CHAPTER 7

GMLSs: PRIMARY FUNCTIONS AND DESCRIPTIONS

The purpose of any delivery unit is to place (launch) a weapon into a desired flight path. That task must be done safely, efficiently, rapidly, and as frequently as the situation demands.

We will discuss the major GMLSs maintained by GMs. There are other missile launching systems in use, but GMs do not man them. These systems include the NATO Seasparrow and the Harpoon and Tomahawk canister launchers.

Before continuing, let's define the terms *mark* and *modification*, commonly abbreviated Mk and Mod, respectively. Each assembled unit of ordnance equipment is identified by a name, a mark number, a modification number, and a serial number. This information is stamped directly on the equipment or on an attached nameplate. A mark number designates a major change in design. Modification numbers are added when there has been minor, but significant, design alterations. Units of identical design have the same name, mark, and mod numbers, but are assigned different serial numbers.

The missile launcher is an integral, but separate, element of the weapons system. The launcher provides support for the missile before and during launch. Initial missile flight orientation is provided by aiming the axis of the launcher along the computed line of fire. The launcher also provides two major electrical connections to the missile. One connection supplies preflight missile orders that are generated by the missile fire control system (MFCS) computer. The other connection supplies firing (ignition) voltage to the propulsion unit of the missile. The firing signal is normally initiated by the weapons direction system (WDS) and weapons direction equipment (WDE).

Launchers may be rigidly attached to the ship or they may rotate in train and elevation axes. The Mk 41 Vertical Launching System (fig. 7-1) is an example of a rigid launcher. The Mk 26 and Mk 13 Mods 4 and 7 are examples of rotating axes launchers.

As you study chapters 7 and 8, pay particular attention to the terminology associated with each system. For effective communication, we cannot overemphasize the necessity for using correct technical terminology. For example, what is the difference between a fixed rail and retractable rail? These terms refer to a common launching system component whose basic function is to stow or guide a movement of the missile. The use of correct terminology when talking about a particular system is absolutely essential. Some system components do have slang names that are generally recognized by all GMs and, if appropriate and within good taste, the manual will mention them. For more "colorful" definitions, go ask your chief!

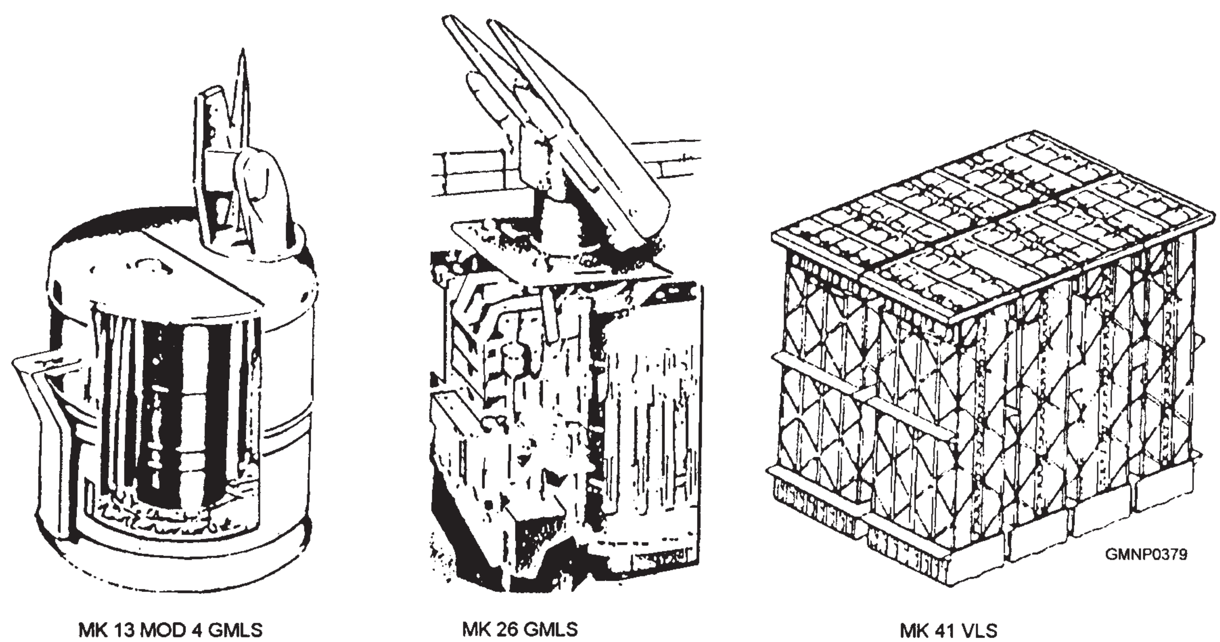


Figure 7-1.—Major GMLSs.

Additionally, throughout the chapter, some component descriptions will include various size dimensions. They are given only so you will have a better idea of a physical arrangement.

MK 13 MODS 4 AND 7 GMLS

LEARNING OBJECTIVES: Explain the purpose/function of the Mk 13 Mods 4 and 7 GMLS major components.

We will now study the Standard launching system by covering a launcher commonly known as the "one-armed bandit." The Mk 13 Mod 4 GMLS is installed aboard FFG-7 *Oliver Hazard Perry*-class ships and the Mk 13 Mod 7 is installed aboard CGN-36 *California*-class ships. They provide a varied tactical arsenal of missiles to engage air and surface targets. It stows, selects, identifies, loads, aims, and fires Standard SM-1, SM-2, and Harpoon missiles.

The Mk 13 Mod 7 GMLSs were originally built as Mods 0, 1, and 3, but because of the design changes in the control system giving the launcher Mod 4 characteristics, they are now designated as Mod 7s. The text will address the Mk 13 Mod 4 configuration. The Mod 7 has the same configuration as the Mod 4.

CAPABILITIES

The Mk 13 Mod 4 (fig. 7-2) GMLS can stow up to 40 missiles, one of which will be a guided missile training round (GMTR) in the rotating ready service ring (RSR) cells of the magazine. The outer ring stows 24 missiles and the inner ring stows 16 missiles. The system is capable of identifying up to seven types of missiles, A through G, plus the GMTR.

The main structural units of the magazine are the base, the outer shell, the inner structure, and the stand. A plenum chamber, attached to the base, vents gases if a missile accidentally ignites in the magazine. The inner structure houses, among other components, the train and elevation power drives, the RSR/hoist power drive, the launcher relay control box, and the missile dc power supply. In operation, the RSR rotates (between the outer shell and the inner structure) to position the selected missile at the hoist station for loading onto the launcher.

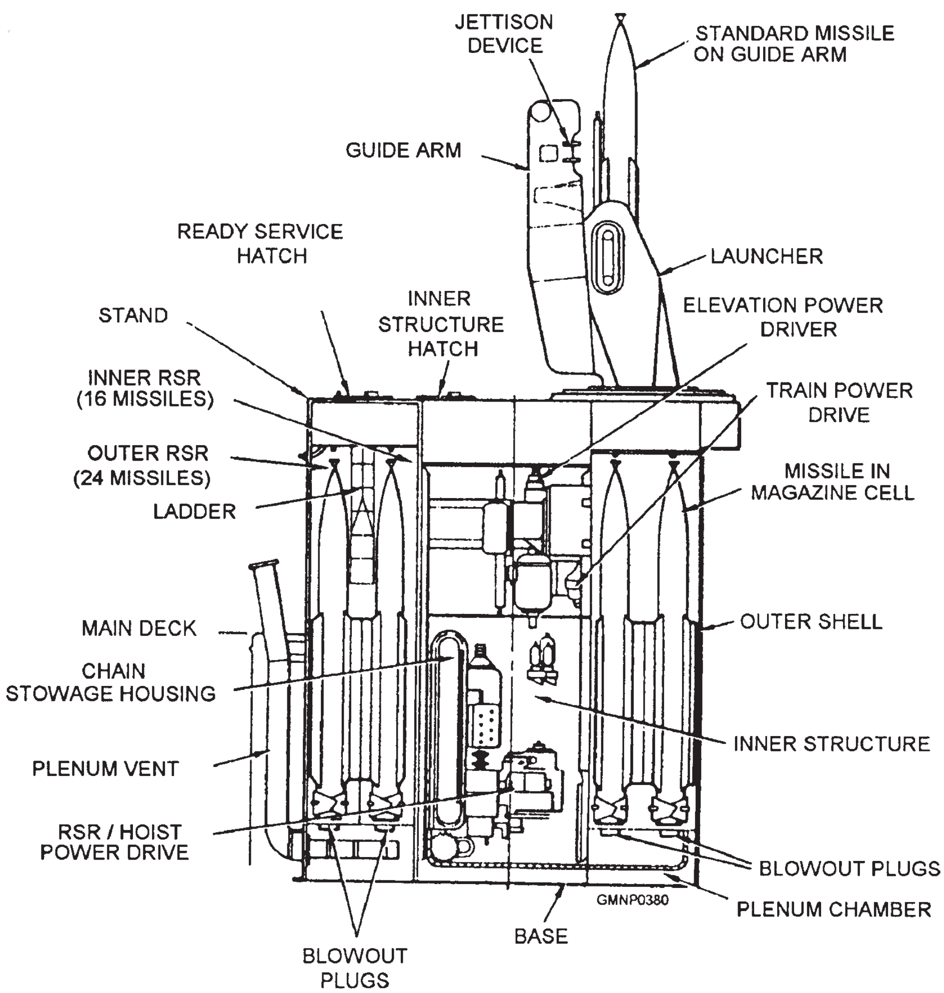


Figure 7-2.—Mk 13 Mod 4 GMLS.

The missile launcher carriage has unlimited motion in train. The elevation load angle is 90°. The two train load positions are 0° (inner ring) and 180° (outer ring) (fig. 7-3).

Automatic pointing cutout systems prevent pointing a missile at any part of the ship. A firing cutout mechanism prevents firing missiles in areas hazardous to personnel and at the ship's structure. Individual ship's structure determines pointing and firing cutout zones.

A dud-jettison unit is an integral part of the launcher guide. The dud-jettison unit ejects missiles overboard that fail to fire and are unsafe to return to the magazine.

Modes of Control

The Mk 13 GMLS has two modes of control: automatic control and step control. Automatic control is the normal mode for loading a missile onto the guide arm and for unloading a missile from the guide arm to the magazine. The weapons control system (WCS) selects continuous loading or single loading to load and launch missiles in automatic control. Continuous loading initiates loading and launching until the magazine is empty or until WCS halts the operation. Single loading initiates the same operations as continuous loading, except that after launching one missile, the launcher trains and elevates to the LOAD position to await further orders. The operation resumes when WCS orders another single loading or continuous loading.

Also, if properly set up, the fire control system (FCS) can remotely light off the launching system and auto-load (or auto-unload) a selected type of missile. The launcher can be aimed and a missile fired before the GM can return from the mess decks with a fresh cup of coffee.

Step control is the step-by-step sequencing and operation of the Mk 13 GMLS components by manual switching at the EP2 panel. The system can be operated in step control to load and launch missiles in a tactical situation if the automatic control circuitry becomes inoperable. Missiles may be loaded onto the guide arm in step-load and may be unloaded into the magazine in step-unload. System components may also be cycled in step-exercise. Interlocks in the system ensure that selected step control functions are sequentially correct. Indicating lamps on the EP2 panel signal completion of each component function.

The launcher train and elevation systems operate under remote and local control signals. The FCS computer generates remote orders. Local orders come from synchro transmitters within the launching system control.

Functional Operation

Upon selection of a Standard or Harpoon missile in the magazine, the weapon is hoisted onto the single guide arm. Harpoon missiles receive initial warm-up on the guide arm. (Standard missiles do not require warm-up.)

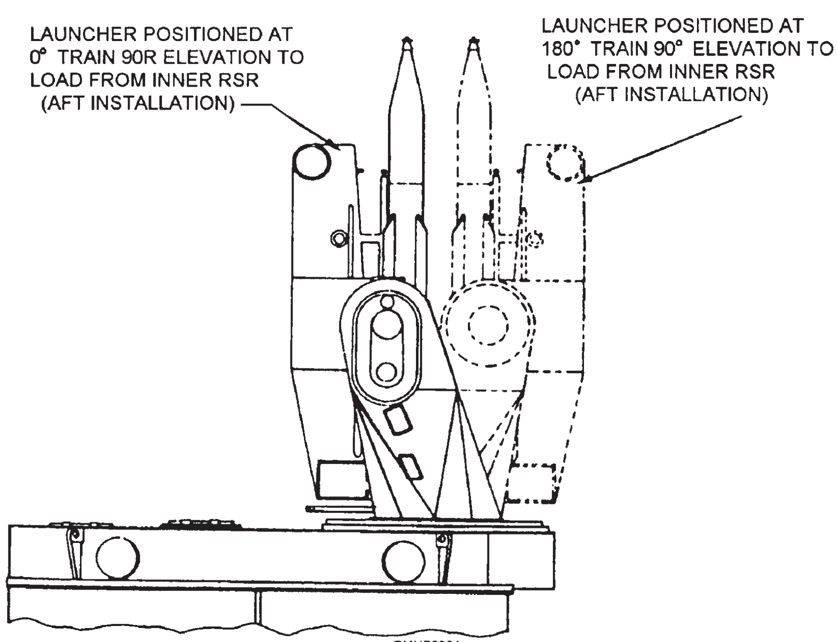


Figure 7-3.—Mk 13 Mod 4 GMLS, launcher load positions.

The launcher trains and elevates in response to order signals from WCS to aim the missile toward the predicted target. When the launcher synchronizes within 1° either side of the ordered position and the missile is ready internally, WCS may initiate firing. After the missile fires, the launcher automatically returns to the LOAD position to receive the next missile selected for loading from the magazine.

During continuous launching operations, the system is capable, under ideal conditions, of a successive firing rate of (1) Standard missiles at 10-second intervals and (2) Harpoon missiles at about 22-second intervals. This action continues until a cease-fire order is given or the missile capacity (excluding the GMTR) of the magazine is exhausted.

Personnel Requirements

A launcher control station contains controls and indicators to regulate and monitor launching system operations. Under normal operating conditions, the Mk 13 GMLS requires the services of a launcher captain and a safety observer. The launcher captain supervises the overall operation of the system and performs all functions at the EP1 and EP2 panels as directed by WCS. The safety observer watches the launcher area and warns the launcher captain of unsafe conditions.

LAUNCHER

The Mk 13 GMLS consists of three major component areas, which are the launcher, the magazine, and the launching system control. We will discuss the launcher first, then the magazine. Again, watch the terminology.

The launcher (fig. 7-4) is a self-powered major assembly that supports, aims, and prepares the missile for firing. Part of the launcher is on top of the stand, while the rest of it sits within the magazine structure. The main components of the launcher are the guide, the carriage, and the train and elevation power drives.

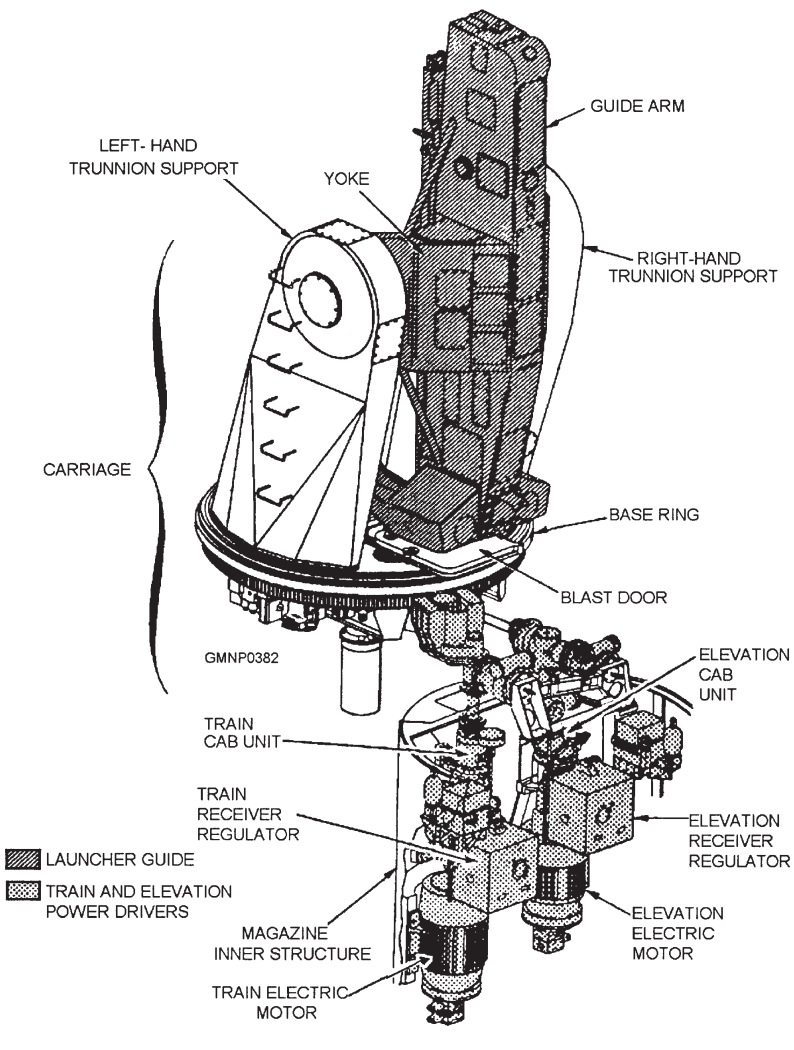


Figure 7-4.—Mk 13 Mod 4 GMLS, launcher.

Launcher Guide

The single arm launcher guide is mounted between the left- and right-hand trunnion supports and consists of the guide arm structure and a yoke. The guide arm holds and prepares the missile for firing. The yoke is an extension of the guide structure, or weldment. It pivots on trunnions extending from the left- and right-hand trunnion supports. The yoke also provides a weatherproof housing for some guide components and serves as a passage for electrical cables and fluid lines.

FIXED GUIDE RAIL.—The fixed rail (fig. 7-5) is slightly less than 30 inches long and is secured to the lower or aft end of the guide arm structure. In addition to forward and aft shoe tracks, it contains an internal track for the hoist chain, the pawl, and the rollers. A cam track engages a special pair of rollers on the chain to compensate for any hoist chain overtravel as it extends up to the launcher. This is called the adjustable buckling chain link and is shown in figure 7-12. The cam track directs any excess chain into an upward curving chamber midway within the fixed rail.

An actuator arm in the forward left section of the fixed rail is a safety device. Through mechanical and hydraulic interlocks, it prevents the aft-motion latch from prematurely retracting during an unload cycle until the hoist pawl properly engages the aft missile shoe.

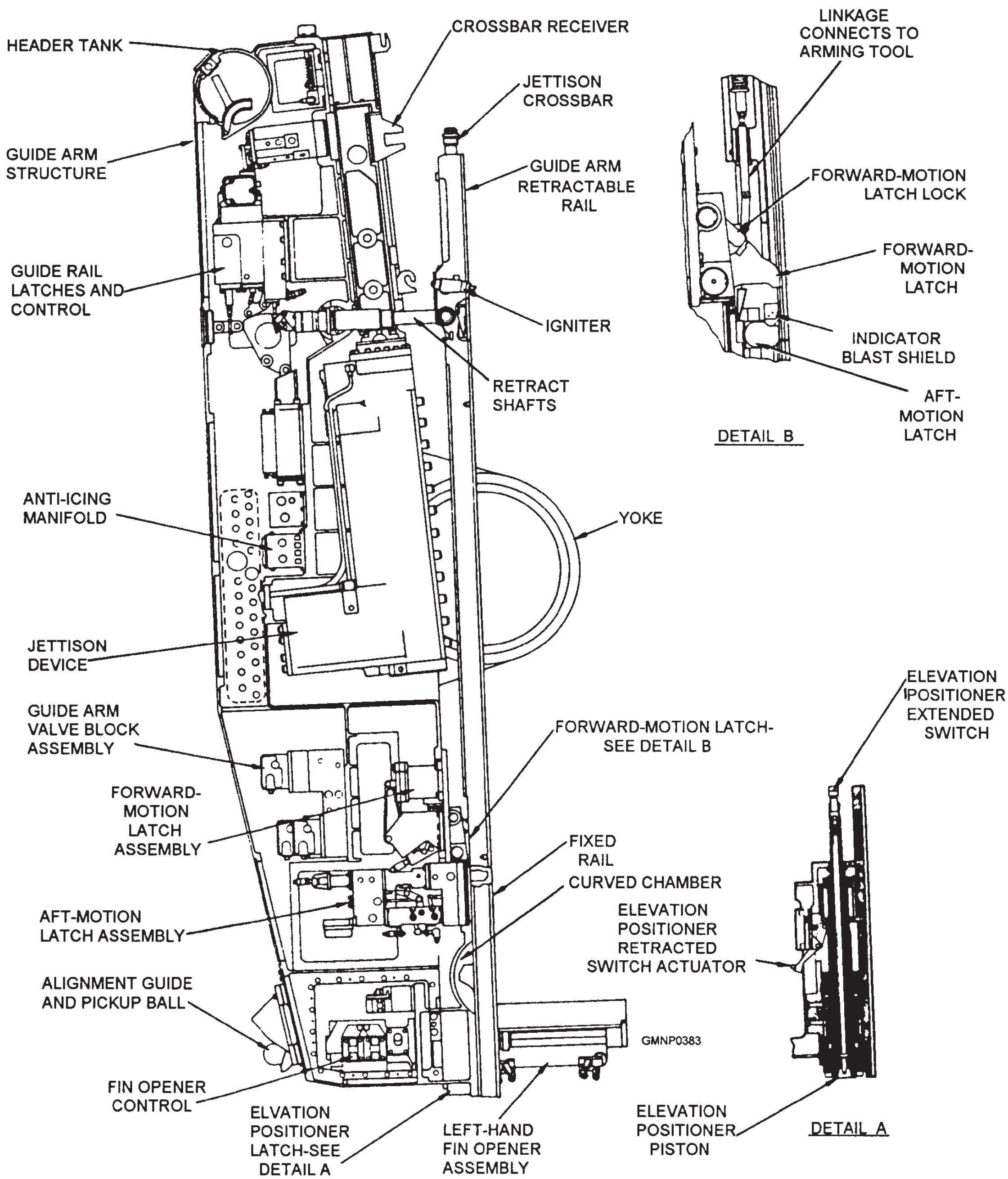


Figure 7-5.—Guide arm.

LAUNCHER RETRACTABLE RAIL.—The launcher retractable rail is an 8-foot-long unit that pivots between two positions. It remains extended except when the fired missile goes into free flight and during a jettison operation. During missile firing, it guides the missile for the first 20 inches of travel and then retracts so the aft shoe and fins do not strike it. For jettisoning a missile, the rail must be in the retracted position to engage the jettison mechanism.

A pivot unit connects the aft end of the retractable rail to the guide arm structure. The two retract shafts at the forward end of the retractable rail extend or retract the rail by means of the rail operating piston and control valve block. Latches secure the rail in the extended or extracted position. A cable within the right-hand shaft contains leads for the rocket motor igniters. The left-hand shaft contains some of the components of the rail retract trigger.

The rail retract trigger is a pivoting bar that protrudes through a slot at the forward end of the retractable rail. When contacted by the forward shoe of the fired missile moving forward, the trigger initiates the mechanical and hydraulic actions that retract the rail.

The arming tool is located between the rocket motor igniters. It mechanically opens and closes the circuitry between the missile firing contacts and the ignition squibs of the rocket motor. The tool is a cylindrical piece that contacts the arming lever of the missile. It is actuated by a spring-loaded rod and linkage mechanism attached to the latch lock of the forward-motion latch. Disengaging the latch lock arms the rocket motor.

Aft-Motion Latch.—The aft-motion latch (fig. 7-5, Detail B) is located near the pivot point of the retractable rail. This device is a stop that prevents a missile from moving backward on the retractable rail. The latch is a hydraulic piston that extends behind the aft shoe of the missile. One of its associated mechanisms is a rod that mechanically detects when a missile is on the guide arm. This rod also provides a discharge path for electrostatic charges on the missile surface. Another plunger of the aft-motion latch pivots a piece on the hoist pawl to disengage it (hoist pawl) from the aft shoe of the missile.

Forward-Motion Latch.—The forward-motion latch (fig. 7-5, Detail B) is a dual-purpose stop. It acts as a positive stop when the hoist raises a missile onto the retractable rail. Until missile firing or jettisoning, the latch also restrains the missile from moving forward on the rail and falling onto the deck.

The latch is a steel piece that pivots into and out of the track chamber of the retractable rail, where it makes contact with the aft shoe of the missile. The forward-motion latch and its operating mechanism provide a 2,320-pound restraining force that holds the missile on the guide arm. When fired or jettisoned, the missile overcomes this force, pivoting the latch out of the track chamber.

The forward-motion latch lock is a movable piece that bears against the forward-motion latch. The lock provides the positive stop when the hoist raises a missile onto the retractable rail. During the missile firing sequence, a release piston disengages the latch lock. Through linkage, this action causes the arming tool to arm the missile.

The Mk 13 also has a key-operated lock in the release piston linkage. When closed, the key-operated lock prevents the forward-motion latch lock from disengaging and, in turn, causing the missile to arm. The launcher captain uses the keylock as a safety device to prevent accidental arming of the rocket motor during missile checkout or inspection.

FIN OPENER AND CONTACTOR ASSEMBLY.—Functionally, the identification probe (fig. 7-6) is used twice in system operation. During an initial strikedown on-load of a missile, the fin opener assembly is extended to the missile. The probe connects the missile-type information to the control system of the launcher. There it is stored in the identification memory circuits as missile-type and cell-location data. When this action is accomplished, the fin opener assembly is disengaged and the missile may be unloaded into a cell.

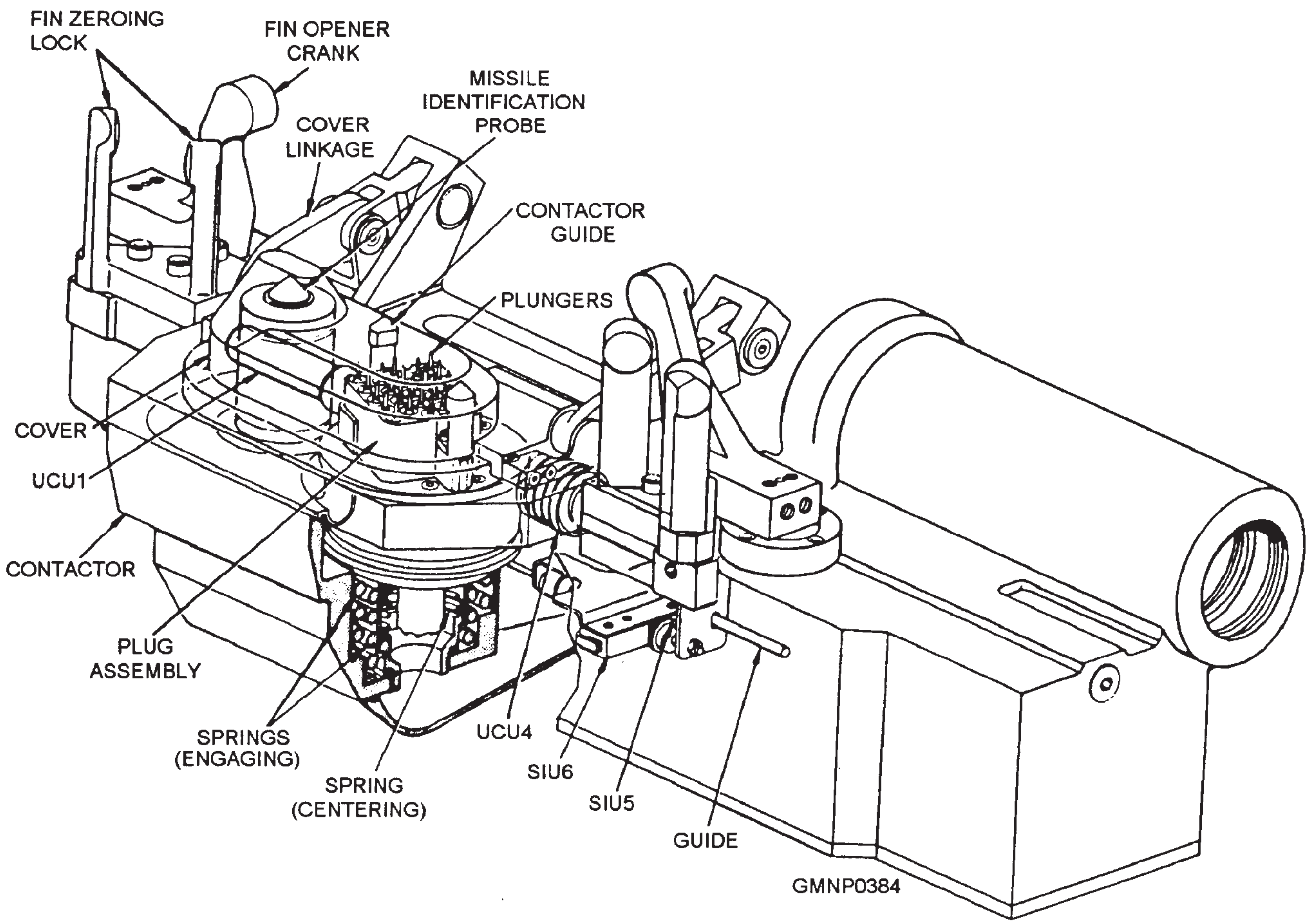


Figure 7-6.—Right-hand fin opener and contactor assembly.

During a load-and-fire operation, the fin opener assembly and probe are engaged again to recheck missile identification. If the type of missile on the guide matches the type of missile ordered from the RSR, preflight orders/Harpoon warmup are applied to the missile. Otherwise, circuits to the 23-pin contactor will remain open and the incorrect missile cannot be launched.

ELEVATION POSITIONER.—The elevation positioner consists of a hydraulic piston and a latch at the aft end of the guide arm structure (fig. 7-5, Detail A). When the blast door is open and the launcher guide is at 90° elevation, the tapered nose of the piston extends down to engage a spud on the door. This locks the launcher guide to the carriage. The piston, or positioner, retracts up into a bore within the guide arm structure to allow launcher elevation movements. The latch prevents the positioner from springing out due to a loss of hydraulic fluid pressure or because of vibration.

Carriage

The carriage (fig. 7-7) is mounted on the magazine stand and is the support structure for the launcher guide. The carriage rotates in response to mechanical movements of the train power drive and transmits the mechanical movements of the elevation power drive to the launcher guide. In addition, the carriage connects the launcher guide with electrical cables, hydraulic lines, and anti-icing lines. The main components of the carriage are a right-hand trunnion support, a left-hand trunnion support, and a base ring.

TRUNNION SUPPORTS.—The right-hand trunnion support is a weatherproof, 8-foot-high housing bolted over an opening in the base ring. The structure contains an opening in its base through which the elevation chain drive extends.

The trunnion is a drive shaft keyed to the yoke on one end and splined to the elevation arc on the other. This shaft transmits movements of the elevation arc to the launcher guide. The trunnion helps support the launcher guide and rotates on bearings mounted within an opening of the trunnion support.

The elevation chain drive is a chain and sprocket assembly that transmits the movements of a drive shaft in the base ring to the elevation arc. Four chains connect the lower sprocket to the upper sprocket. Each sprocket assembly has four wheels. The drive shaft in the base ring rotates the lower sprocket. The upper sprocket turns the elevation drive pinion that moves the elevation arc. The chain guide, near the lower sprocket, is a four-channel track that bears outward on the four chains to dampen their vibrations when operating. The chain tightener, near the upper sprocket, is also a four-wheel sprocket with an adjustment screw for establishing and maintaining the proper chain tension.

The left-hand trunnion support is physically similar to the right-hand structure. It holds the non-driven trunnion shaft and mainly serves to route cables and hoses up to the fixed rail and rotates with the base ring.

BASE RING.—The base ring is a circular, blastproof structure about 6 1/2 feet across and 17 inches high. It is designed to rotate within an off-center opening of the stand. The base ring also supports various components located inside the stand and trunnion supports.

Blast Door and Fixed Rail.—The blast door is a movable weldment that pivots up and aside to allow the transfer of a missile between the magazine and the launcher guide. With the door latched open, a spanning rail (about 4 1/2 inches long) on one side of the weldment aligns with a fixed rail on the base ring and the fixed rail on the guide arm. These rails provide the continuous tracks for the missile and the hoist. Also, when the door is open, a spud on the door aligns with the elevation positioner on the guide arm. The blast door drive is a hydraulic unit that opens and closes the blast door. One piston raises and lowers the door and another pivots the door sidewards through a 95-degree arc.

A small section of guide rail is attached to the structure of the base ring just below the blast door opening. It is called the fixed rail and rotates with the base ring. The fixed rail spans the distance between the top of the inner and outer retractable rails of the magazine and the spanning rail of the blast door.

Launcher Guide Power Unit.—The launcher guide power unit is an accumulator-type power supply that provides hydraulic fluid pressure to components in the launcher guide and the blast door. This power supply uses an electric motor to drive a rotary pump submerged in the main supply tank. A valve block regulates and filters the hydraulic fluid before charging three accumulators. Part of the structure of the base ring forms the supply tank for the launcher guide power unit.

Train and Elevation Mechanical Drives.—The train circle gear is mounted to and around the perimeter of the structure of the base ring. It is an external spur gear that meshes with the train drive pinion. Movement of the pinion rotates the base ring and launcher on the stand bearings.

Elevation drive components transmit the rotary motion of the elevation B-end motor to the chain drive mechanism in the right-hand trunnion support. A combination of shafts, couplings, and a planetary differential gearbox is in the base ring area.

Electrical Contact Ring.—The electrical contact ring (another term for a slip ring) is an electrical transfer device that allows continuous connections between the rotating base ring and the stationary magazine structure. The ring suspends from the bottom of the elevation planetary differential.

Train and Elevation Power Drives

The text will provide thorough coverage of the Mk 13 GMLS power drives in chapter 5. The Mk 13 GMLS power drives are mounted in the top inner structure of the magazine. (See fig. 7-4.)

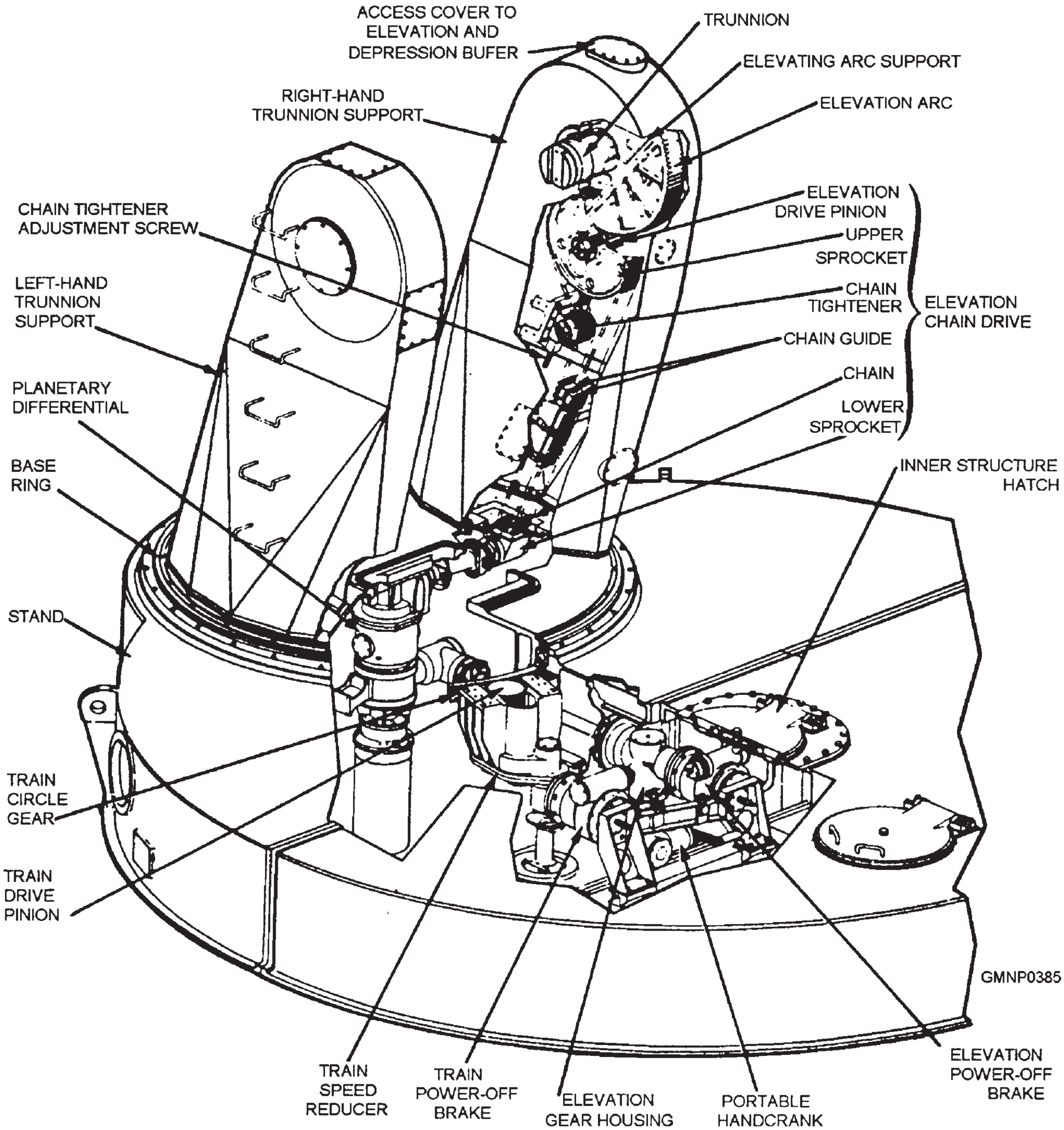


Figure 7-7.—Launcher carriage.

MAGAZINE

The Mk 13 GMLS magazine (fig. 7-8) stows the missiles, transfers them up to or down from the launcher, and serves as a mounting pedestal for the launcher. The magazine may be divided into four main structural areas that contain the various major equipment assemblies.

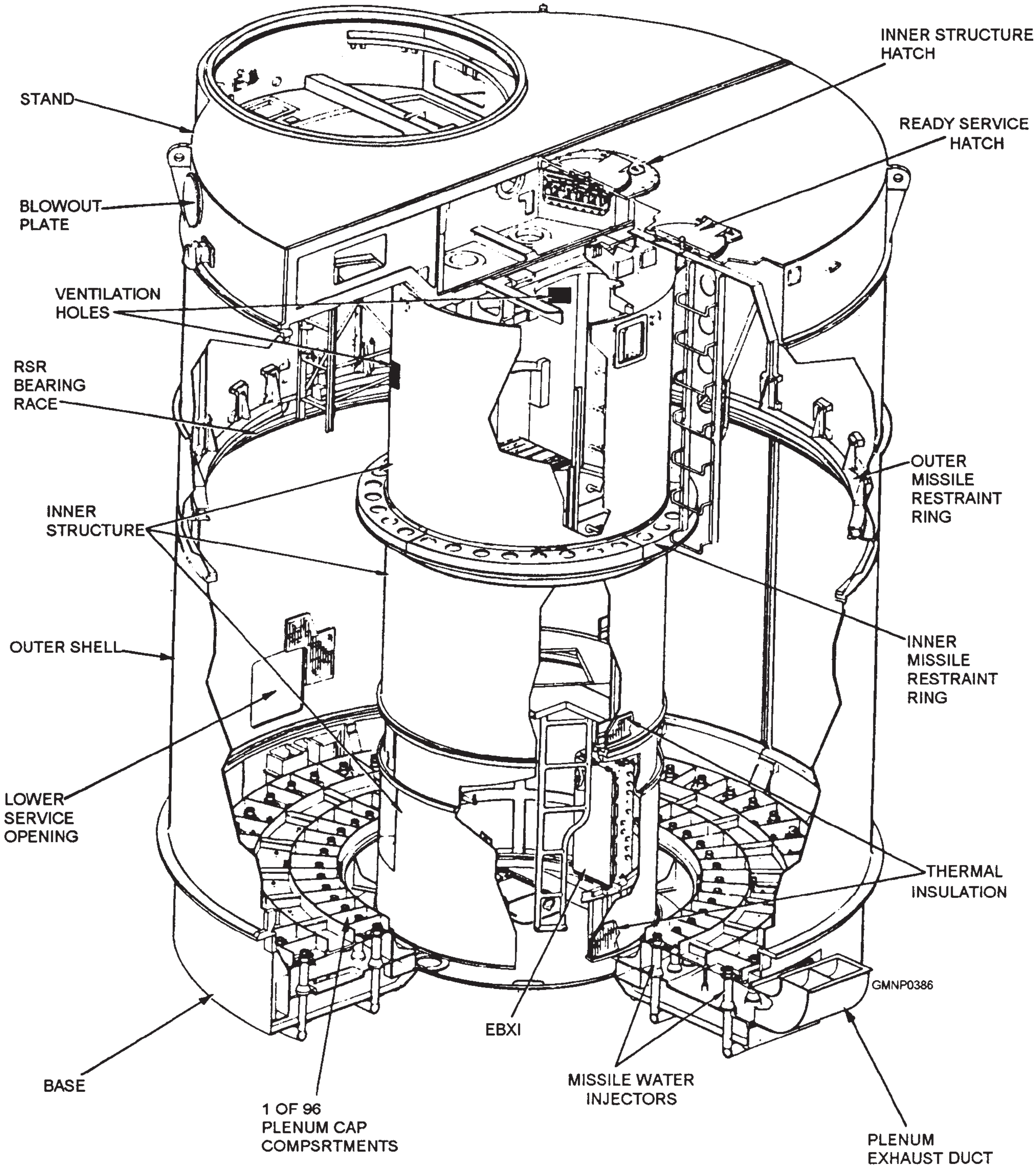


Figure 7-8.—Magazine structure.

Stand

The stand (shown in figure 7-8) is a stationary, round structure about 3 feet high. It forms the entire top part of the magazine structure. Besides the off-center base ring opening, the stand has four blowout plates equally spaced around its circumference. Two personnel hatches lead to the inner structure and the RSR areas.

Outer Shell

The armor-plated outer shell is the structure between the stand and the base. Service openings are located near the bottom and halfway up the shell. They provide access to the warmup contactors and RSR components, respectively. A bearing race for the RSR rollers is attached to the upper section of the shell. A four-segment missile restraint ring is directly above the bearing race. If a missile accidentally ignites in the magazine, the restraint ring holds it in place.

Inner Structure

The inner structure (fig. 7-9) of the magazine is in the center of the outer shell. It is made up of three sections: top, middle, and bottom.

The top inner structure is essentially a cylindrical shell with several mounting pads. The magazine hydraulic power supply main tank and the train and elevation hydraulic power drive main tank are integral parts of the top section. This section also contains a missile restraint ring similar to the one in the outer shell.

The middle inner structure has openings and components for the warm-up electrical contact ring. The RSR radial bearings are in the rims at the top and bottom of this section.

The bottom inner structure, the shortest of the three sections, has five rectangular openings. Three of the openings have covers that provide access to a ring gear, warm-up contactors, and a hoist track. The other two openings are for the RSR drive pinion and drive housing.

Base

The magazine base (shown in fig. 7-8) is at the bottom of the magazine structure. Its main components are a base structure, a plenum cap, a flame tight hatch, 96 blow-in plates, and 96 water injectors. The base adds lateral strength to the outer shell, contains all the magazine service connections, and houses the missile

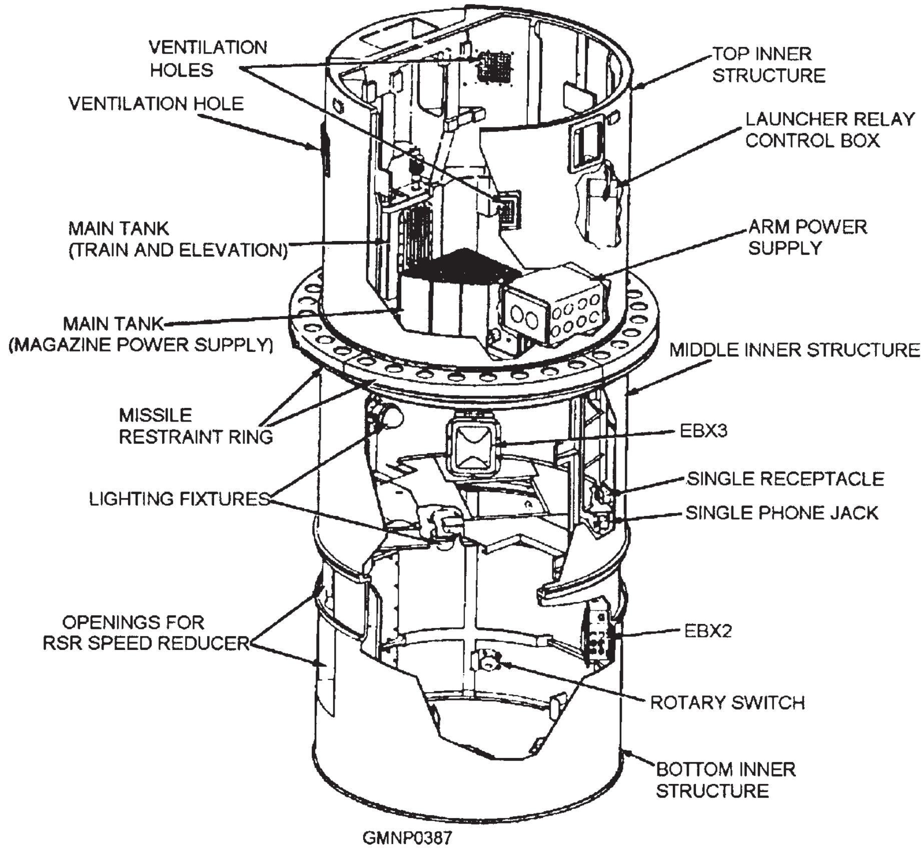


Figure 7-9.—Inner structure.

water injection system. If a missile ignites in the magazine, the plenum chamber receives the exhaust gases and conducts them to an elbow-shaped duct at the edge of the chamber. From here, the gases escape into the atmosphere.

The plenum cap contains a total of 96 compartments under the RSR cells. Under the 16 inner ring cells, there are 3 compartments for each cell (48). Under the 24 outer ring cells, there are 2 compartments for each cell (another 48). As a result, a compartment is always underneath each missile for any of the 32 possible RSR index positions. Each of the 96 compartments holds a blow-in plate assembly and a water injector nozzle.

Ready Service Ring (RSR)

The RSR (fig. 7-10) is a separate rotating structure inside the magazine between the inner structure and the outer shell. It indexes the cells clockwise or counterclockwise to deliver selected missiles to the inner or outer hoist positions. A station-at-hoist interlock switch produces a lamp indication on the EP2 panel, informing the operator which cell is at the selected hoist position.

A hydraulic B-end motor inside the inner structure drives the RSR. A speed reducer, consisting of a series of gear trains enclosed in a housing, connects the B-end output shaft to a speed reducer drive pinion. The pinion meshes with the RSR circle (ring) gear. Two radial bearings support the RSR laterally on the inner structure. Twenty-four roller assemblies fastened to the upper RSR rim between each cell support the RSR vertically. These rollers ride on a roller path mounted on the outer shell. A positioner (or latch) under the RSR locks the structure in any one of 32 index positions. The positioner blade engages locking clevises along the lower circumference of the RSR.

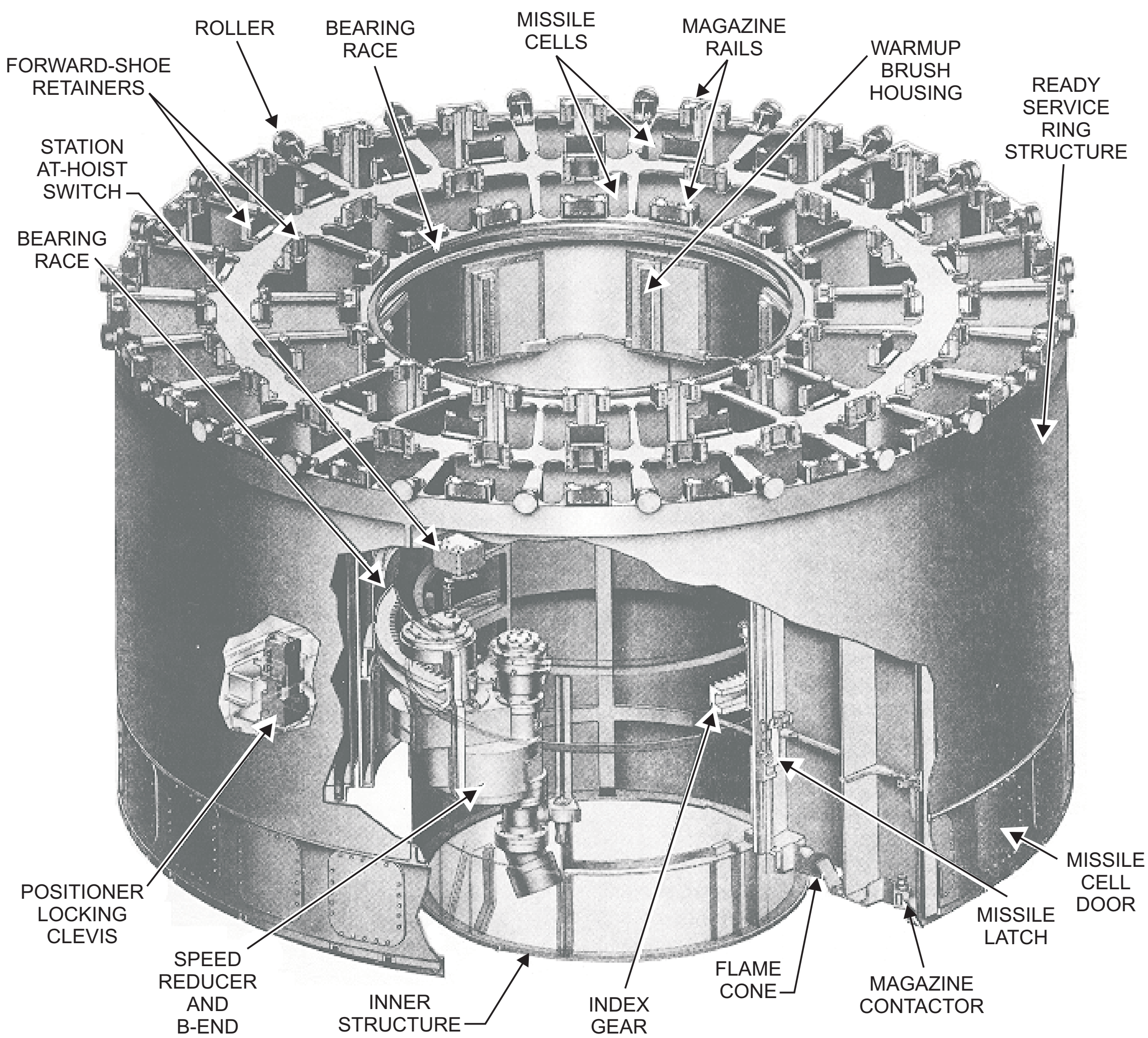


Figure 7-10.—Ready service ring.

A magazine contactor is at the bottom of each cell. As a missile lowers into a cell, a male-type connector plug in the contactor enters a female-type receptacle in the base of the missile. That establishes system-to-missile connection. Through this device, missile cell identification circuits are possible.

Each cell has one full-length magazine rail that guides and supports the missile and hoist chain. A missile latch near the bottom of the rail locks the aft shoe of the missile in the cell. On the opposite wall of each cell is a forward-shoe retainer. It engages one of the forward shoes to help steady the missile in the cell. Also, at the bottom of each cell is a flame cone. The cone directs the flame of an ignited missile into the plenum chamber. Access to each cell is through individual doors along the lower inner and outer walls of the RSR.

Hoist Assembly

The components of the hoist assembly (fig. 7-11) perform all vertical transferring of the missiles. The

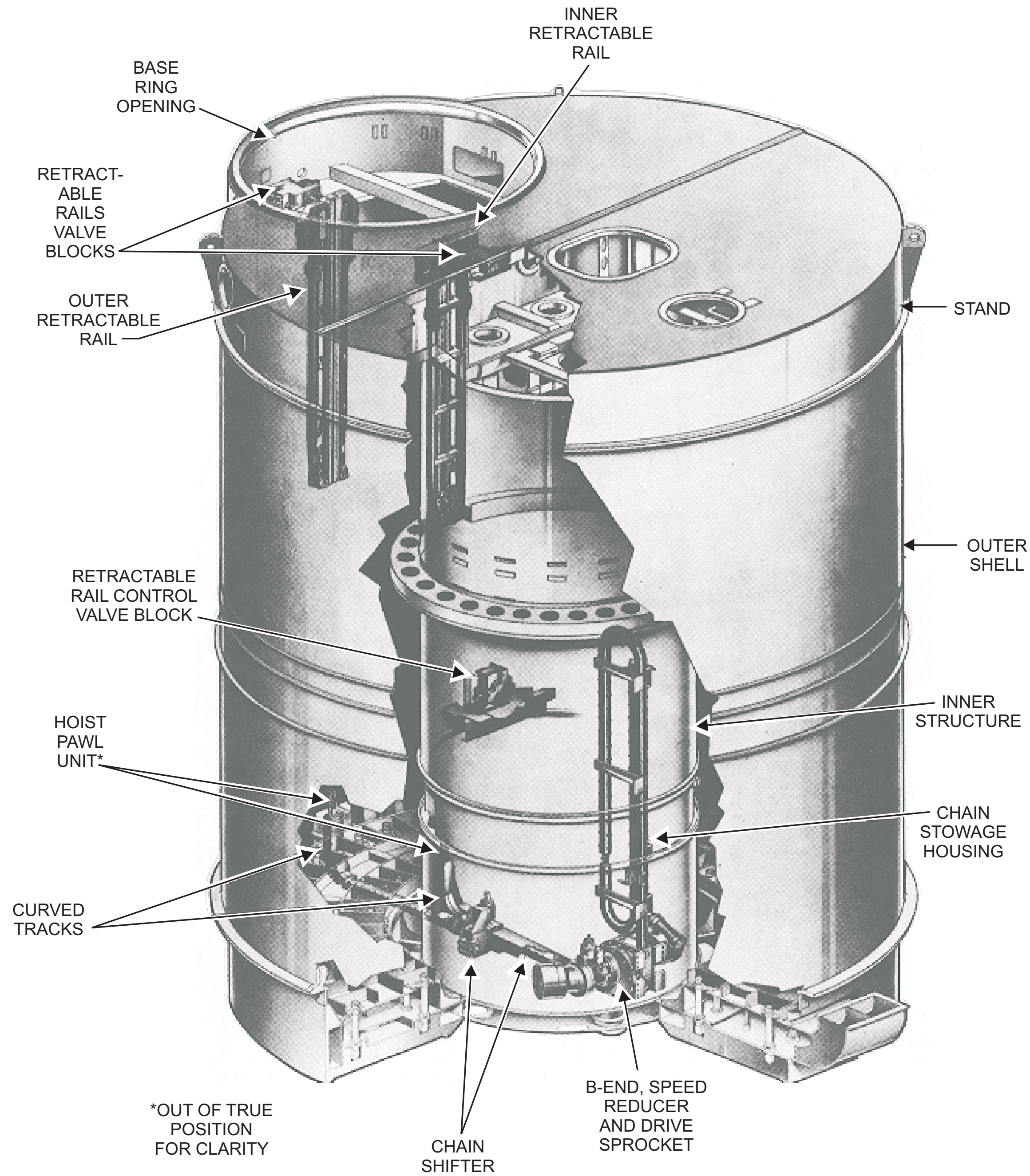


Figure 7-11.—Magazine hoist.

hoist chain (fig. 7-12) is an open-end roller and link-type chain with cam-type projections and detentes on some specific links. They actuate interlock switches and valves, couple with the shifter half-links on the hoist pawl units, and act as travel limit-stops.

The chain stowage housing, mounted in the inner structure, stows a majority of the length of the chain when it is retracted. A small section of chain remains exposed on the drive sprocket and in the chain shifter. The hoist B-end hydraulic motor connects to a speed reducer and drive sprocket that drives the chain.

The hoist chain shifter is a hydraulically operated device located between the drive mechanism and the curved tracks. It raises or lowers the hoist chain's shifter half-link into alignment with either the inner or the outer hoist pawl unit's shifter half-link (see fig. 7-12). Two curved track assemblies, one for the inner ring and one for the outer ring, serve to guide the hoist chain and connected pawl unit. They pivot out and up to the magazine rail of the cell at the selected hoist position. Additionally, the hoist pawl units are stored in their respective curved track sections when the hoist chain is fully retracted at the magazine position.

A hoist pawl unit is extended to engage the aft missile shoe to load a missile. As the hoist pawl reaches the intermediate position (the point where the aft shoe of the missile rests), a cam follower forces the pawl latch to pivot sufficiently away from the pawl link to

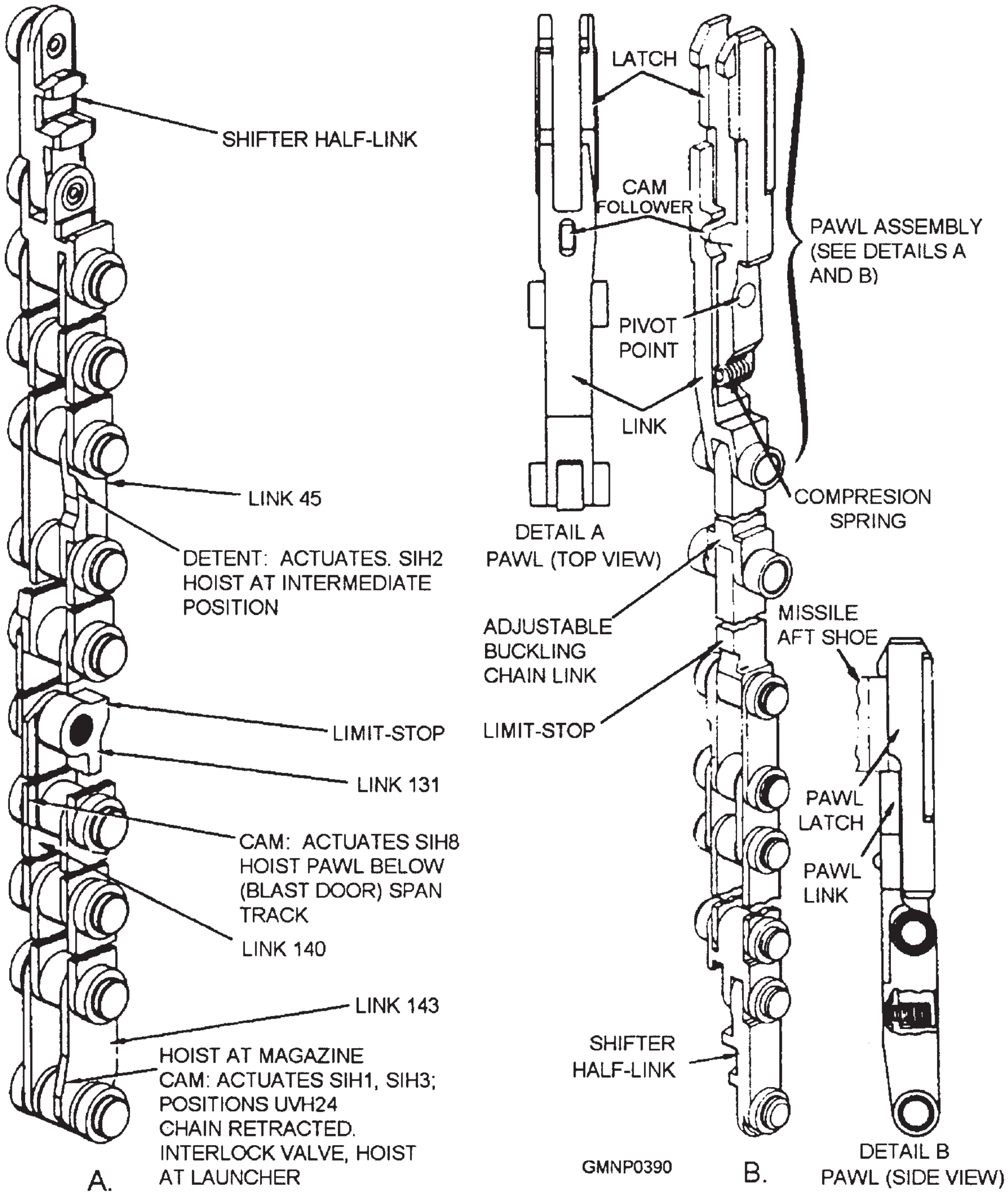


Figure 7-12.—Hoist chain components: A. Hoist chain; B. Outer hoist pawl.

clear the aft shoe. At the same time, other surfaces on the hoist pawl are unlocking and camming the cell latch open. The pawl link contacts the bottom of the shoe. A compression spring returns the pawl latch to its normal position, closing over the top of the shoe. The missile is then raised to the guide rail of the launcher. There the aft-motion latch mechanism extends and pivots the pawl latch to release it from the aft shoe. The missile is now secured to the launcher rail and the chain retracts to the magazine.

Associated with the hoist assembly are the inner and outer retractable rails of the magazine. (See fig. 7-11.) When either rail extends, it forms a continuous track between the magazine rail of the station at the hoist position and the fixed rail mounted on the carriage base ring. With both retractable rails retracted, clearance is provided between the missile heads and the RSR during RSR rotation. Only one retractable rail may extend at a time.

Magazine Hydraulic Power Supply

The magazine power supply furnishes hydraulic pressure to operate components of the RSR/hoist power drive (refer to fig. 7-2) and other units in the magazine (that is, retractable rails, RSR positioner, and chain shifter). The power drive consists of an electric motor that drives a hydraulic A-end pump. The pump provides hydraulic fluid pressure to either the RSR B-end or the hoist B-end. A hydraulic control valve shifts or redirects the output of the A-end to the selected motor.

It is not unusual to see this type of arrangement (one pump or A-end capable of driving two individual motors or B-ends) in ordnance systems. In the Mk 13 GMLS, the RSR cannot index while the hoist is cycling (and vice versa). This type of power drive is very practical in design and results in a smaller, more compact unit.

Harpoon Warmup

A Harpoon missile does not require warmup in the magazine, but does require about 10 seconds' warmup on the guide arm. Harpoon warmup power is applied through the fin opener arm (23-pin) contactor.

LAUNCHING SYSTEM CONTROL

The launching system control is the control, power distribution, and test center for the GMLS. The main components are the EP1, EP2, and EP3 panels located within the launcher control station (fig. 7-13). Other

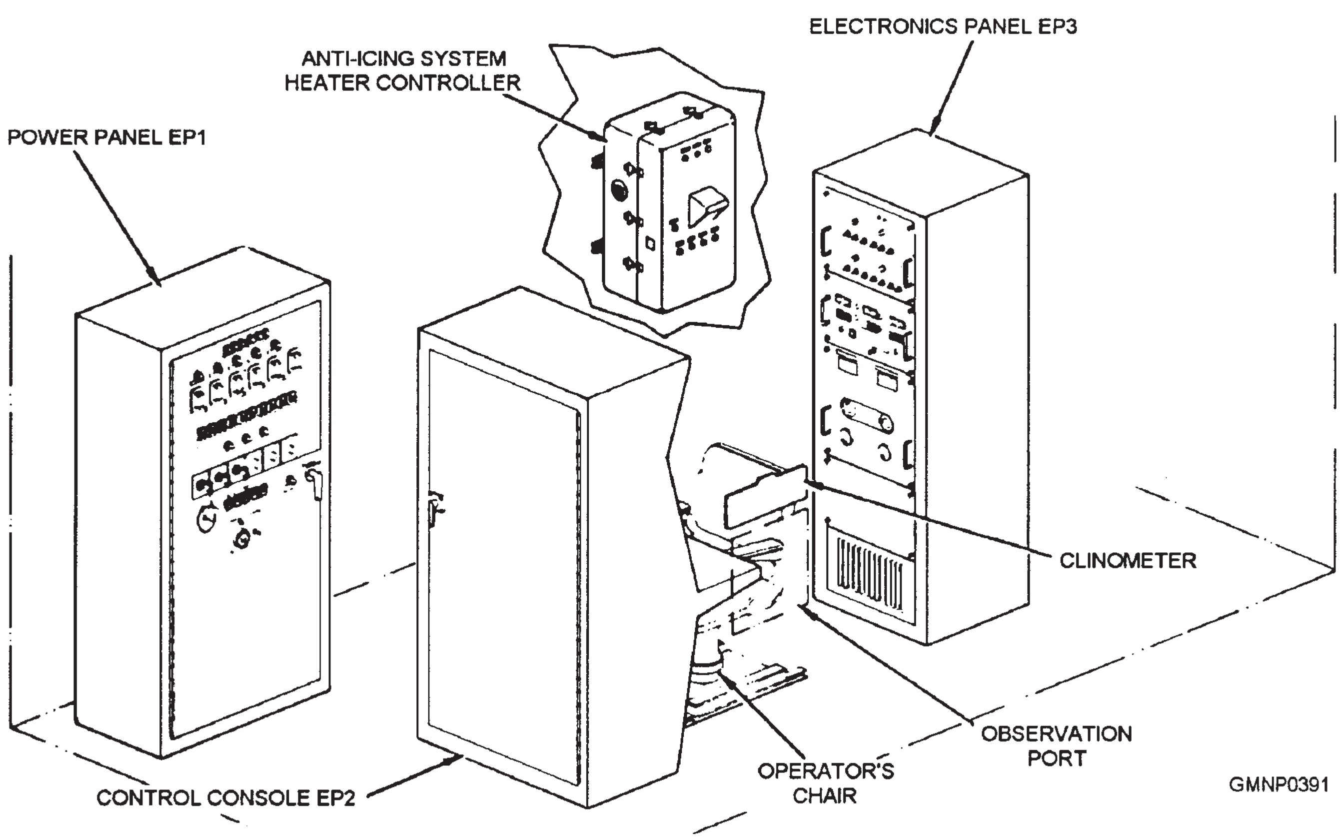


Figure 7-13.—Launcher control station.

components in or near the launcher control station are the power transfer device (PTD), an inter-communication unit, a strikedown hand control, a clinometer, a safety observer switch, jacks, and receptacles. The strikedown and safety switch receptacle and a telephone jack are mounted outside the control station.

Power Panel, EP1

The EP1 panel (fig. 7-14) is the power distribution unit for the launching system. This panel contains 115- and 440-VAC power indicators, circuit breaker on/off switches, fuses, elapsed time indicators, ground detection indicator, and system safety and power supply switches. The system safety and power supply switches are a two-position rotary keylock switch that controls the system motors. In the SAFE position, the switch opens the start/run circuit of the motor. The key may be removed (and retained) by system personnel. This is a safety feature that prevents system operation when personnel are working around rotating machinery. A solenoid-operated latch locks the door when power is available to the panel.

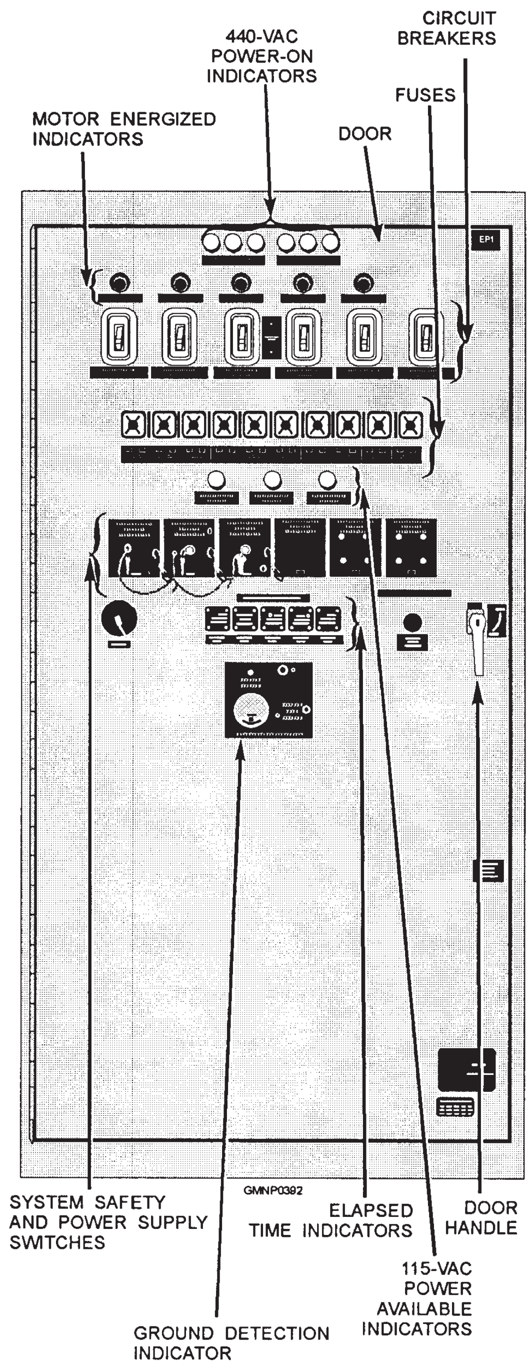


Figure 7-14.—Power panel, EP1.

Control Console, EP2

The EP2 control console (fig. 7-15) is the control unit for the GMLS. It contains the operating controls and indicators on two angular sections on the upper part of the console. These controls and indicators allow the operator to select and monitor GMLS operation.

UPPER SECTION.—The upper section contains missile-related switches. The 40 dud assignment switches designate which RSR stations contain dud or normal missiles. Missile code and type assignment switches are thumbwheel switches that assign a designated missile numerical code to type A through type G missiles and T for the GMTR stowed on the RSR in the magazine. Also, rows of indicating lamps light up to display the load status of each station (cell) and identify which station is at the HOIST position.

The Harpoon casualty mode and firing safety switches are connected in the normal and emergency firing circuits. The firing safety switch is another rotary

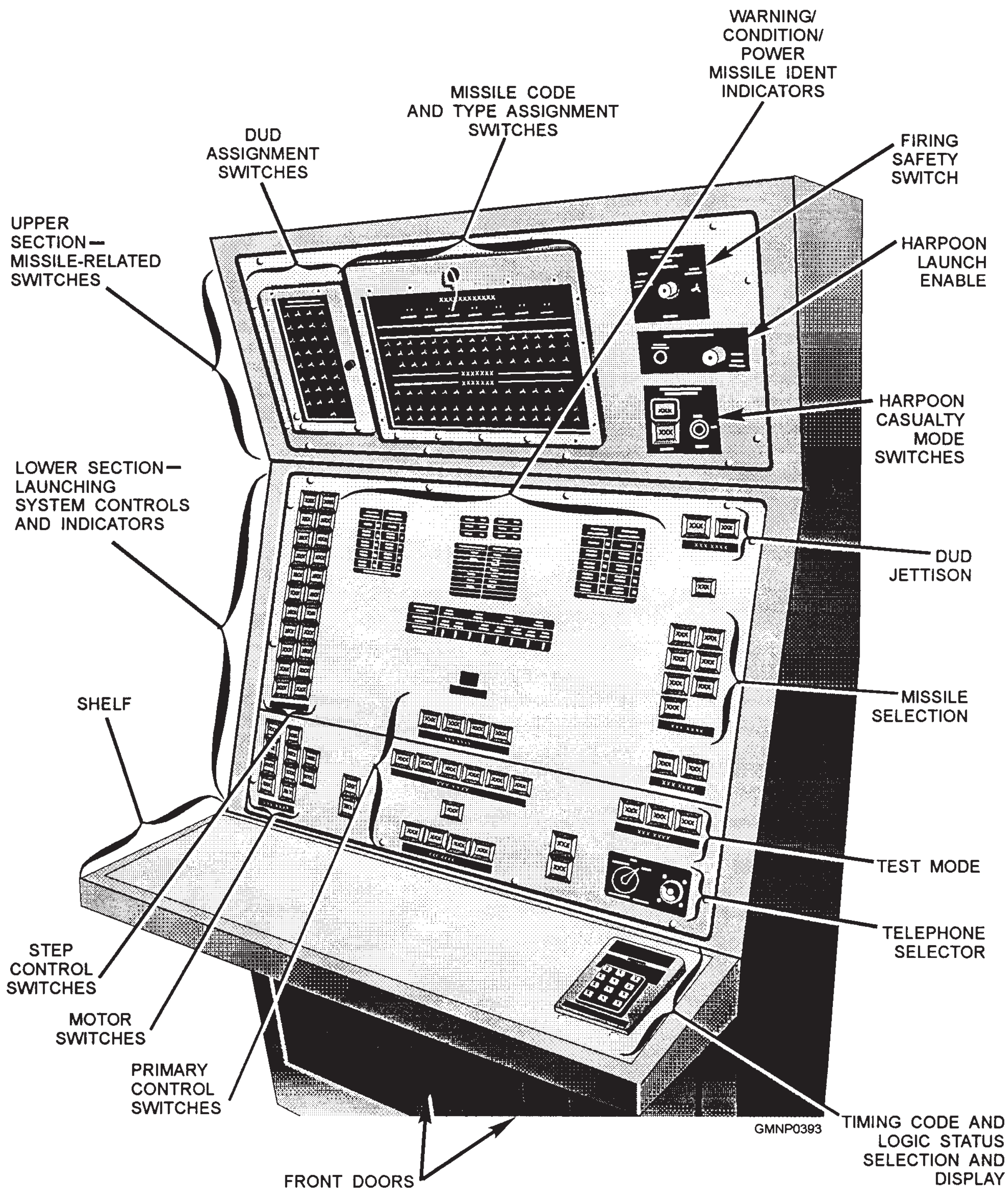


Figure 7-15.—Control console, EP2.

key-type switch. The key is removed in the SAFE position to inhibit the rocket motor firing circuit.

LOWER SECTION.—The lower section of the EP2 contains the launching system controls and indicators. The controls are push-button indicator switches used to activate and select the mode of control and type of GMLS operation. For normal auto/remote control operation, three primary control switch groups at the center of EP2 start the GMLS load-and-fire operation. The remote launcher control or local launcher control push button selects who has control over loading operations. If remote launcher control is selected, FCS controls loading and, if applicable, remote motor starting. In local launcher control, the EP2 operator has control of the system.

The other switches are used with the primary switch groups for motor activation, step, exercise, and test modes of system operation. The indicator lamp groups provide the console operator with information related to the launching system and missile status.

A timing code and logic status (TCLS) selection and display module is on the right side of the shelf. This module is used to troubleshoot and test GMLS operations. Physically, it is very similar to a pocket calculator in size and construction.

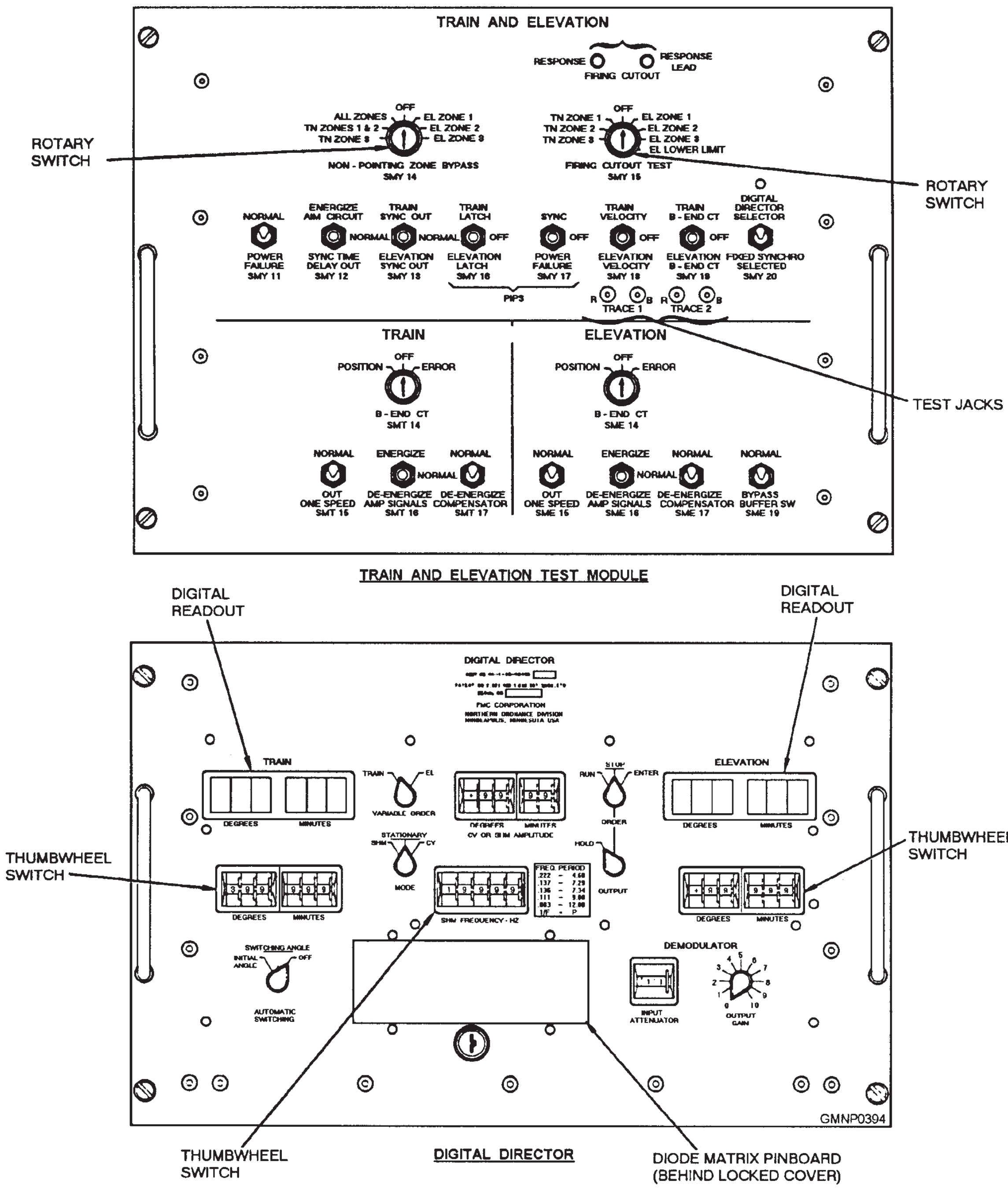


Figure 7-16.—Electronics panel, EP3 (sheet 1 of 2).

Push buttons on the TCLS let the operator enter numerical codes for obtaining information on equipment electrical status and for timing component operations. Light-emitting diode (LED) indicators display timing and circuit status according to the codes (numbers) punched (entered).

INTERNAL COMPONENTS.—Access to components inside the EP2 console is through a large door on the back or two small doors on the front. The components accessible through the back door are the printed circuit (PC) cards on the wire-wrap backplane, fuses, manual handcrank solenoid controls, receptacles with polarizing key positions, electronic component circuit cards, terminal boards, and other miscellaneous components. All components in EP2 are identified by an electrical designation stamped (or applied) on or near each component.

Accessible through the two front doors are rectifiers, low dc voltage power supplies, a rechargeable nickel-cadmium battery, a battery charger, and a fan for component cooling.

The rechargeable battery provides dc power to launching system solenoids under two conditions. If a power failure occurs in the 115-VAC power distribution network during an operational cycle (that is, raising the hoist), the dc battery supply will activate automatically. The battery will provide a dc output for about 5 seconds and permit completion of the interrupted cycle. The second condition is used during maintenance or troubleshooting procedures in a normal power-off condition. System personnel activate the manual handcrank solenoids control and position a selected toggle switch. This actuates a particular solenoid and permits handcrank or handpump operation of a component (that is, extend or retract the launcher retractable rail).

Electronics Panel, EP3

The EP3 electronics panel contains the electronic control and test equipment for launcher train and elevation power drives. The front of the EP3 panel (fig. 7-16) contains the train and elevation test module and the digital director (DD), the local control handwheel module (LCHM), and the electronic servo control unit (ESCU).

The LCHM (fig. 7-16, sheet 2 of 2) generates train and elevation local control position order signals to point the launcher. Digital readouts on the LCHM show launcher train and elevation positions. Response signals from synchros in the train and elevation power drive receiver-regulators operate the digital readouts on the LCHM. The LCHM is the primary local control unit for the launcher and comes on-line automatically when local pointing is selected. During a HARPOON casualty mode, the LCHM is required to point the launcher.

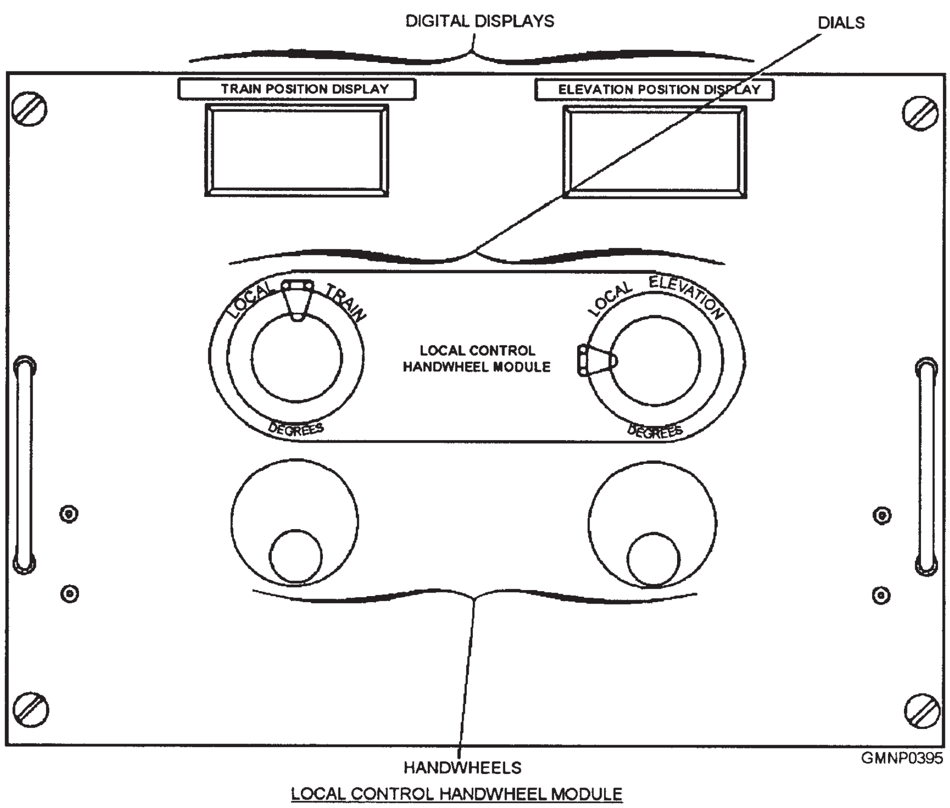


Figure 7-16.—Electronics panel, EP3 (sheet 2 of 2).

The test module is used to test train and elevation nonpointing zones, nonfiring zones, and synchronization of the power drives. It contains switches and jacks to select the tests and record traces.

The DD is used to operate the train and elevation power drives in local control. It is also used with the test module and the electronic servo control unit (ESCU) to check and test power drive operation. The DD has rotary and thumbwheel switches to control the power drives. Digital readouts indicate DD output in degrees and minutes for train and elevation. A diode matrix pinboard, behind a locked cover, generates the stationary position orders for load, strikedown, and jettison operations.

The ESCU is located in the rear of EP3 and is the servo amplifier for the train and elevation power drives. The unit consists of a solid-state amplifier with 13 PC cards on the upper half and amplifier controls and test jacks on the lower half.

MK 26 GMLS AND MODS

LEARNING OBJECTIVES: Explain the purpose/function of the Mk 26 GMLS major components with Mod differences.

The Mk 26 Mods 0 through 5 GMLSs (fig. 7-17) have been designed to be an extremely versatile and sophisticated addition to the missile community. They are installed aboard the DD-993 *Kidd*-, CGN-38 *Virginia*-, and CG-47 *Ticonderoga*-class ships. This GMLS possesses one of the quickest reacting and fastest firing rates of any comparable dual-arm system. Although the *Kidd* and *Virginia* class ships have been decommissioned all Mods will be covered to illustrate the differences.

Constructed with advanced solid-state electronic, hydraulic, and mechanical features, the Mk 26 GMLS is compatible with a variety of fire control systems (Standard, ASROC, and AEGIS). The system also handles a mixed arsenal of missiles including Standard

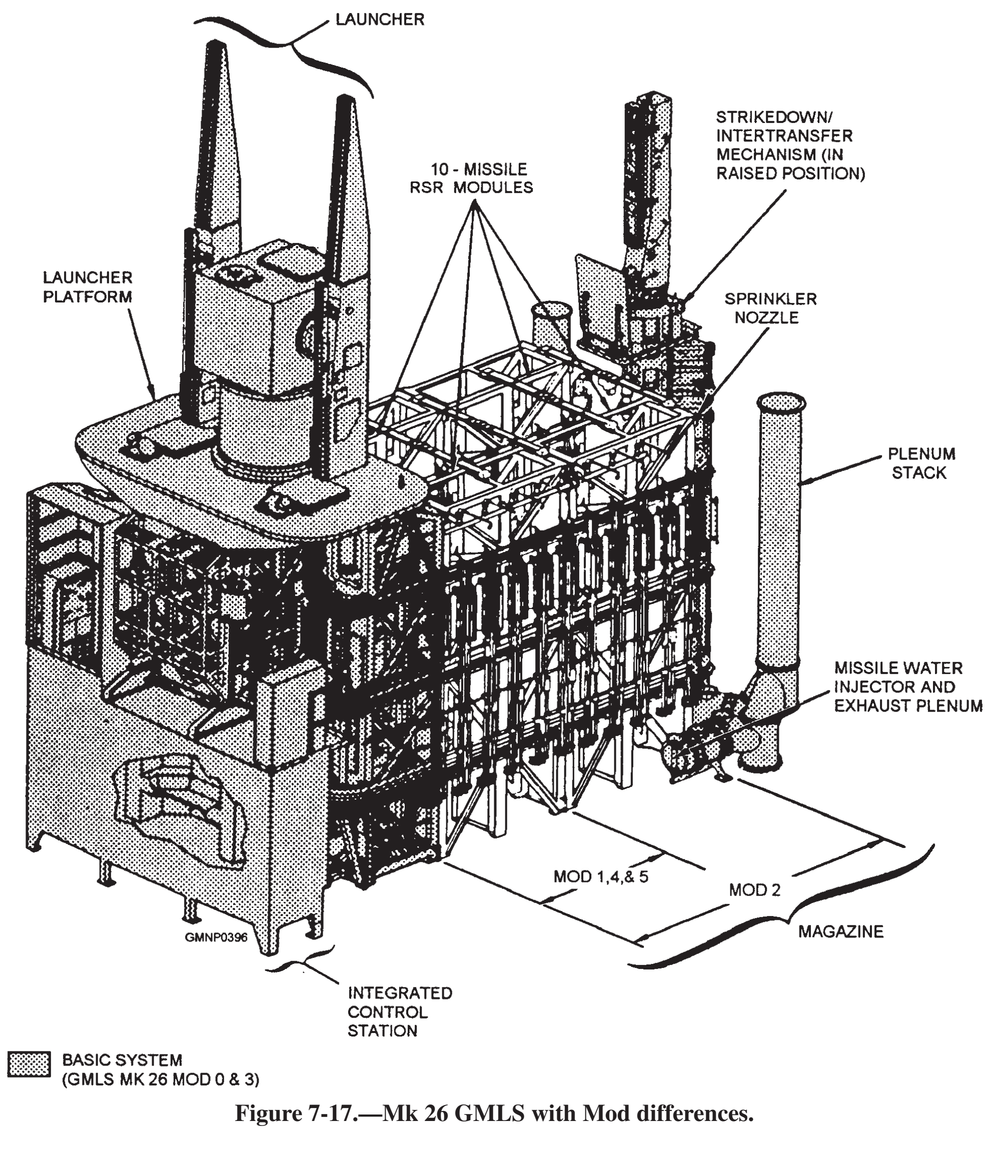


Figure 7-17.—Mk 26 GMLS with Mod differences.

SM-1, SM-1A, and SM-2 rounds and the ASROC (both torpedo and depth charge configurations).

PURPOSE AND CAPABILITIES

As a major subsystem of the ship's combat system, the Mk 26 GMLS consists of a launcher, a magazine, and a launching system control. Depending on the Mod configuration of the system, 24 to 64 missiles are stowed vertically on the two rotating RSRs of the magazine. In response to remote or local commands, the system auto- or step-loads one or two missiles to the launcher. A firing rate of two missiles approximately every 9 seconds (with a 1-second salvo time delay) can be maintained.

The launcher is capable of unlimited train and may be elevated or depressed through an arc of 100°. The elevation load position is about 90°, with one train load position of 0° or 180° for forward- and aft-mounted launchers, respectively. The launcher must be within 20 minutes either side of the remote signal position to be synchronized with an FCS pointing order.

The launcher performs all missile preflight preparations like other GMLSs except for unfolding the missile fins. That action is accomplished in the magazine. Additionally, an adapter rail for the ASROC missile is not required on the Mk 26 GMLS.

The RSRs independently index the nearest selected missile(s) to the hoist position at one end of the magazine. When the RSR indexes a missile to the other end of the magazine, it aligns with the strikedown/intertransfer mechanism. System on-load, off-load, and intertransfer (from one RSR to the other) operations are performed here.

The launching system control (fig. 7-18) is the brain of the launching system. Its electrical/electronic equipment controls all launching system operations in response to ship computer signals. The integrated control station (ICS), located below the launcher in front of the two RSRs, is the major component of the launching system control. All the control panels and equipment necessary to activate the system, monitor its operations, initiate local orders, and transfer automatic control to weapons control are in this compartment. In

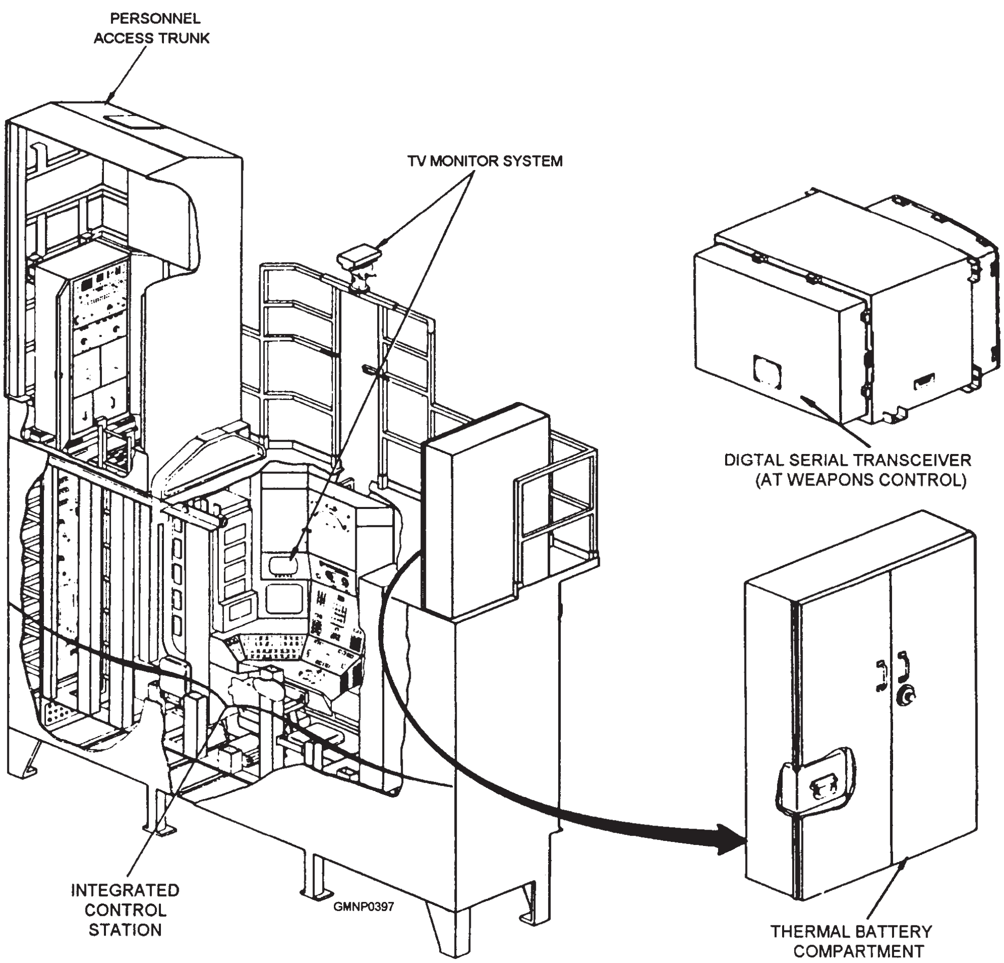


Figure 7-18.—Launching system control components.

addition, the ICS houses all the testing and cycle monitoring equipment needed for maintenance procedures.

The ICS operator can communicate directly with other shipboard command stations through a 20-station ship communication network as well as sound-powered telephone circuits. Also, the operator can watch the whole operation of the launching system. Two special high-strength windows in the front of the ICS let the operator see into the forward parts of the magazine. A closed-circuit television system with two remotely located cameras allows the ICS operator to monitor on-deck actions and parts of the magazine not visible through the windows during all system operations.

MOD AND SERIAL NUMBER DIFFERENCES

The Mk 26 GMLS is currently divided into six different Mods that differ mainly in missile-stowage capacities and "value engineering design changes." Refer to figure 7-17.

The magazine of the Mod 0, called the basic system, contains two RSRs that can stow 12 missiles each. By adding one 10-missile module to each RSR, the Mod 0 becomes a Mod 1; likewise, by adding two 10-missile modules to each RSR, the Mod 0 becomes a Mod 2. The Mod 0, then, can stow 24 missiles; the Mod 1, 44 missiles; and the Mod 2, 64 missiles. The first eight systems manufactured were assigned serial numbers 1 through 8 and are currently the Mods 0, 1, and 2 systems. They are primarily installed on the CGN-38 Virginia class.

Mk 26 systems with serial numbers 9 through 18 have incorporated valuable engineering design changes into various components of the launching, loading, strikedown/intertransfer, and control system. These design changes alter the physical characteristics of components and systems without affecting their functional characteristics. Generally, these minor design changes were made to reduce system cost and weight. They also improved system reliability, maintainability, and availability (RMA). These systems were originally built as Mod 0s and Mod 1s but, because of the number of changes made, are now designated Mod 3s (old Mod 0s) and Mod 4s (old Mod 1s). They are primarily installed on the DDG-993 Kidd class.

The Mk 26 Mod 5s are installed on the CG-47 *Ticonderoga*-class ships with the AEGIS weapons system. Additional design changes have been made to interface with the AEGIS equipments. The magazine capacity is the same as Mod 1 and 4 systems.

The magazine size of the different Mods also affects some auxiliary equipment. The amount of piping needed for the sprinkling and water injection systems grows with the magazine stowage capacity. The extra piping also needs more pressurized seawater. Ship air-conditioning demands differ among the various Mods.

The launcher is the same for all six Mods. Except for internal logic circuitry and some panel displays, the ICS for each Mod is the same. The strikedown/intertransfer mechanism is unchanged. However, additional RSR modules do move the mechanism farther from the launcher.

PERSONNEL REQUIREMENTS

For normal tactical operation, four persons are required to run the system. The main control console (MCC) operator activates, readies, and monitors system functioning. A launching system captain is in charge of the ICS and supervises total system operation. Two other personnel are assigned as fin assemblers/folders and remain at-the-ready in the ICS. They also help observe magazine equipment operation through the two observation windows and visually verify that correct missiles are at the hoist positions.

The text will now provide a general physical description of the major component areas of the Mk 26 GMLS. We will use the Mod 0 configuration (the basic system) as our model, and only the A-side equipments will be covered. Be particularly alert to the terminology associated with the Mk 26 GMLS.

MAGAZINE

The magazine is a below deck, weathertight compartment for handling and stowing the missiles in an environmentally controlled condition. Its components perform all operations involved with loading, unloading, strikedown, and intertransfer.

Ready Service Ring (RSR)

A complete 12-missile RSR (fig. 7-19) is made by joining three basic support structures: a hoist end, a six-missile section, and a strikedown end (assembled in that order). The two end sections are structurally similar and provide space to mount three hanger rail assemblies apiece. The six-missile section is inserted between the end sections and is fastened to the

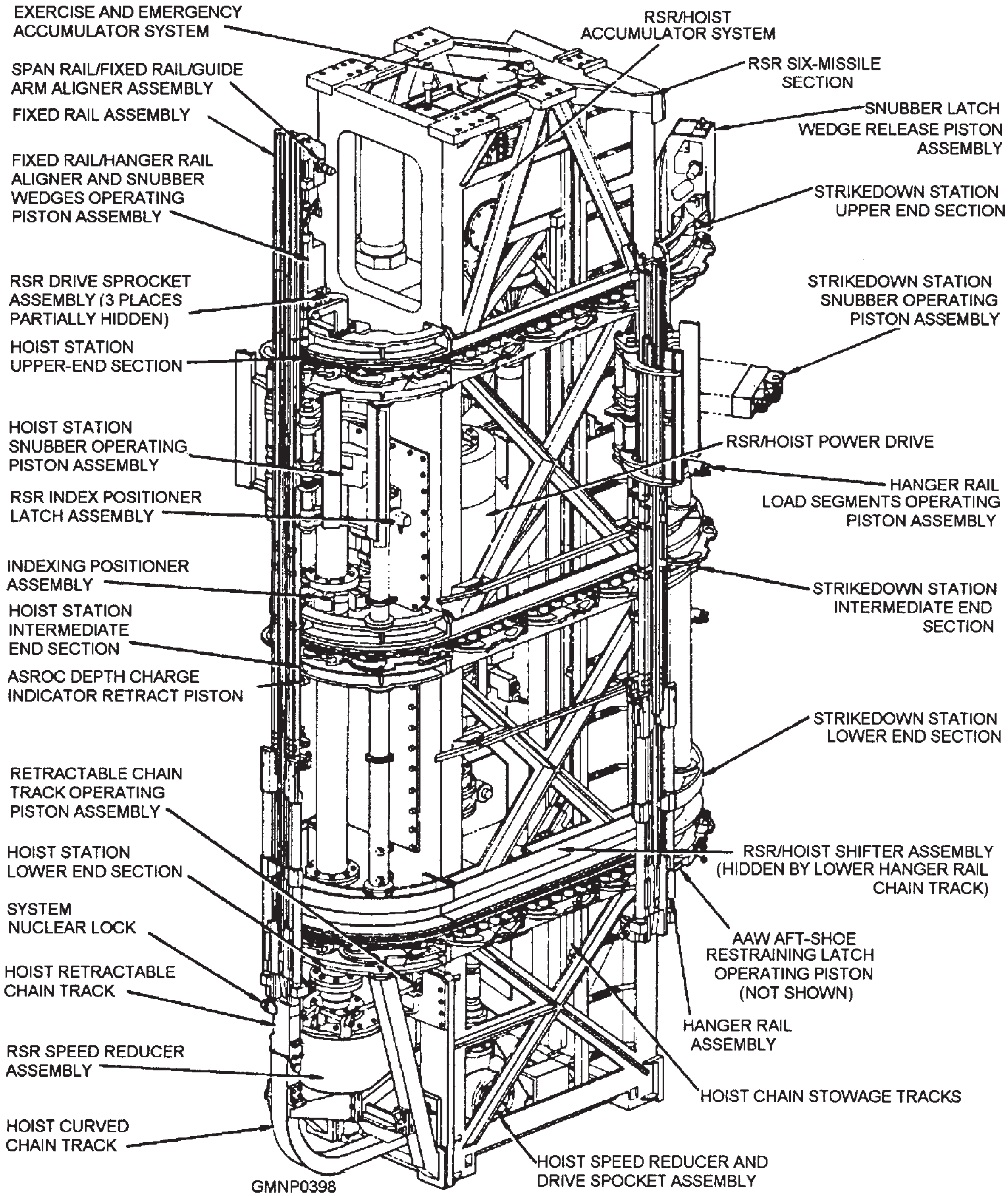


Figure 7-19.—RSR components, general arrangement.

magazine deck. It also supports the launcher platform above. It has space for three hanger rail assemblies along each side.

To increase magazine capacity, either one (Mods 1, 4, and 5) or two (Mod 2) 10-missile sections are added to a basic RSR. (See fig. 7-17.) Physically placed between a six-missile section and the strikedown end, a 10-missile section provides space for five hanger rail assemblies along each side.

Each basic section has three hanger rail chain tracks (upper, intermediate, and lower) that guide the hanger rail chains. A roller track, mounted just above the lower chain track, guides the hanger rail rollers. The hoist end also has six proximity switches gang-mounted near its bottom. As the hanger rails move past these switches, rail-mounted actuators activate them in various combinations. This action identifies to the control system individual hanger rails according to the number assigned them.

Hanger Rail Assemblies

A hanger rail assembly (fig. 7-20) is made up of a 13-foot structural rail column. The individual components of the hanger rail support and hold a missile on the RSR. Mounted on the back of each column are three chain sections with rail links. When joined to other hanger rails, three continuous chains are formed around the RSR. They secure the rails to the RSR and provide a means for indexing. A hanger rail roller supports the assembly vertically in the RSR roller track.

Rail tracks on the front of the column engage and guide the pusher bar, missile shoes, and hoist chain. During loading/unloading operations, the hanger rail at the HOIST position is locked to the RSR fixed rail above it.

SNUBBER ASSEMBLY.—A snubber assembly is mounted to the back of each hanger rail. It has padded arms which close on the missile to stabilize it in the RSR. A hydraulic piston and linkage arrangement at the hoist station and a similar mechanism at the strikedown station actuate the snubbers. The arms open to clear the way for all loading and unloading operations.

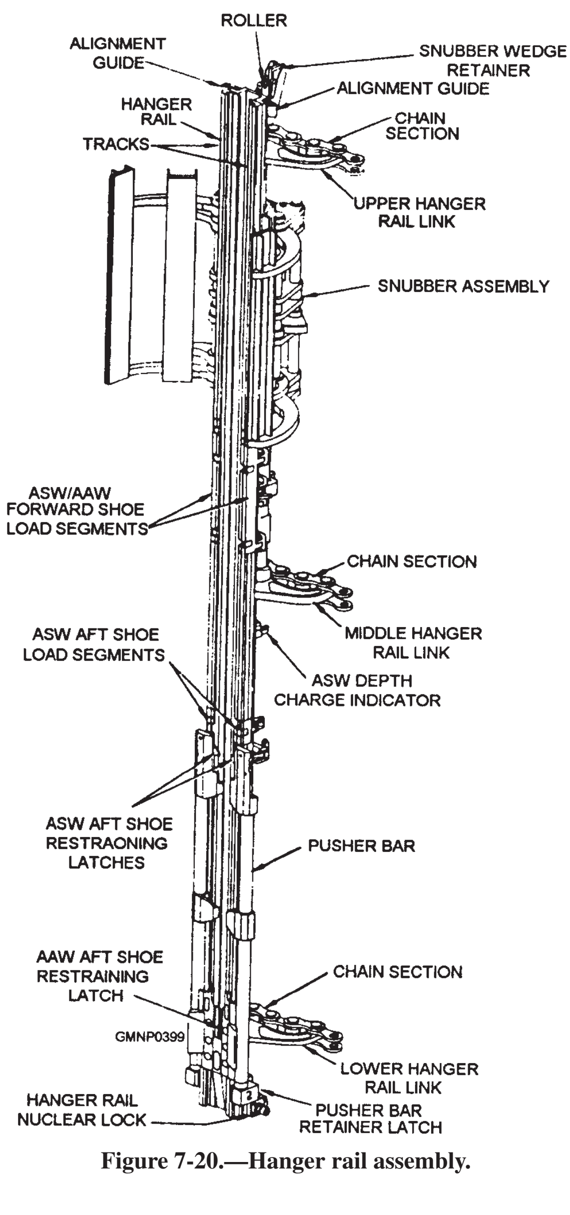


Figure 7-20.—Hanger rail assembly.

PUSHER BAR.—The hanger rail pusher bar is a device that rides in the rail tracks and holds the aft shoes of AAW and ASW missiles. There are three different latch groups associated with the pusher bar. A pusher bar retainer latch at the bottom of the hanger rail locks the bar at its fully lowered position. The latch is retracted by the hoist retractable chain track when it extends to align with a hanger rail at the HOIST position. The retainer latch is spring-loaded to the extended position and reengages the pusher bar when the hoist retractable chain track retracts.

An ASW aft shoe restraining latch is near the top of the pusher bar. An AAW aft shoe restraining latch is near the bottom of the pusher bar. Both latches are spring-loaded devices that close over their applicable aft missile shoe, locking it to the pusher bar. Functionally, during a hoisting operation, the hoist pawl engages the pusher bar and raises it to the launcher. There, guide arm components unlock the (AAW or ASW) shoe restraining latches and disengage the missile from the pusher bar. The hoist retracts, returning the empty pusher bar to the magazine.

LOAD SEGMENTS.—The hanger rail contains two different load segments. They are small, outer sections in the guide track. They pivot open to admit missile shoes to the hanger rail at the strikedown station (only). They close to hold the shoes in the rail at all other times. The upper segment receives the forward shoe of an AAW and an ASW missile. The lower segment receives only an ASW aft shoe. (The AAW aft shoe enters a loading slot cut in the bottom of the hanger rail near the AAW aft shoe restraining latch.) When a hanger rail is indexed to the strikedown station, the load segments align with a hydraulic piston

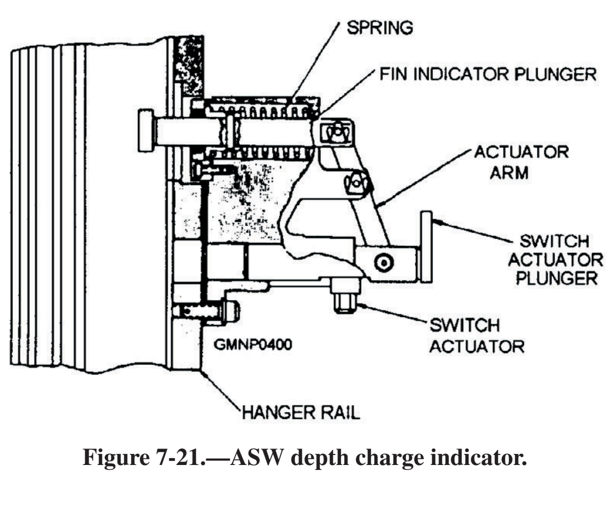


Figure 7-21.—ASW depth charge indicator.

assembly. Through linkage, the load segments are made to open and close as the piston extends and retracts.

HANGER RAIL NUCLEAR LOCK.—Each hanger rail mounts a hanger rail nuclear lock (referred to as a rail lock). This key-operated device functions in conjunction with a system nuclear lock to permit or prevent the hoisting of a missile from that particular rail. The rail lock is locked (or extended) whenever a nuclear missile is initially onloaded into that rail. For conventional missiles, it is normally left unlocked.

ASW DEPTH CHARGE INDICATOR.—The ASW depth charge indicator (fig. 7-21) is a device that informs the control system whether an ASROC depth charge missile is or is not at the hoist station. Mounted to the back of each hanger rail, the device consists of two plungers and a proximity switch actuator.

Functionally, when a depth charge missile is loaded into a hanger rail, one of the fins of the rocket depresses the spring-loaded fin indicator plunger that extends through the rail. This action moves the switch actuator plunger and actuator magnet.

The magnet will activate a proximity switch (mounted to the RSR at the hoist station) when that hanger rail is indexed to the HOIST position. An electronic signal is relayed to the control system indicating a depth charge round is at the hoist station.

Also, before any hoist cycle may start (for any type of missile), the fin plunger must be retracted to allow the hoist chain to pass. A hydraulic piston on the RSR is made to extend and, through linkage, retracts the plunger from the chain track of the rail.

Hoist Assembly

The Mk 26 GMLS hoist assembly (fig. 7-22) is an integral part of the RSR and is very similar to other

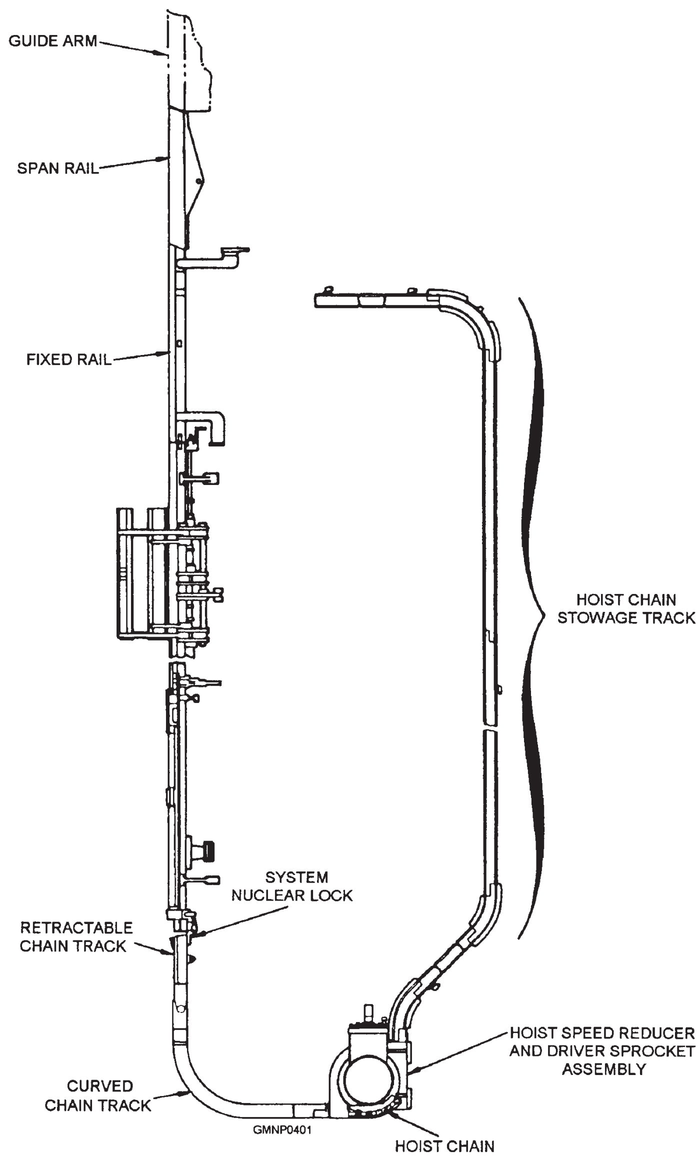


Figure 7-22.—Hoist components, general arrangement.

hoist assemblies. The hoist chain is a link-connected, roller type about 31 feet long with magnet actuators mounted to various links. They activate proximity switches on the chain stowage track that indicate the raised, lowered, and intermediate positions of the hoist.

A hoist pawl and latch, an adjustable link, and a buckling link are on the forward end of the hoist chain. The hoist pawl and latch connect the hoist chain to the pusher bar for hoisting operations. The adjustable link makes possible the proper positioning and alignment of missiles on the launcher guide arm. The buckling link compensates for any overtravel of the chain on an extend cycle.

The curved and retractable chain tracks extend from the hoist speed reducer and drive sprocket assembly to the hanger rail. The curved chain track is stationary. The retractable chain track is a pivoting track that aligns the curved track section with the hanger rail for hoisting operations. When the retractable chain track extends, it actuates a mechanical linkage that releases the pusher bar retainer latch.

SYSTEM NUCLEAR LOCK.—The system nuclear lock (also known as the RSR lock) is a device similar to the hanger rail nuclear locks (fig. 7-23). It is mounted to the retractable chain track of the hoist. Both

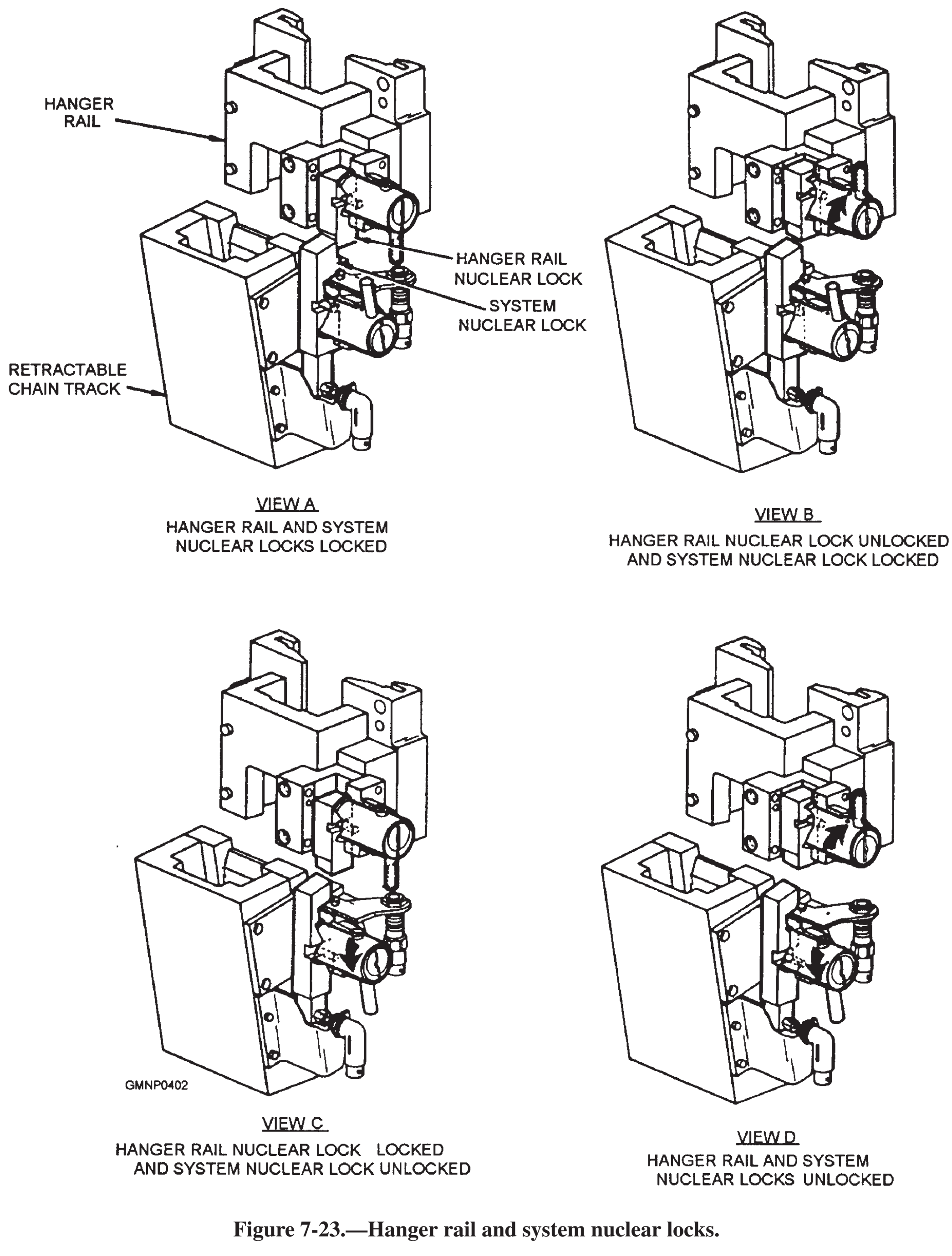


Figure 7-23.—Hanger rail and system nuclear locks.

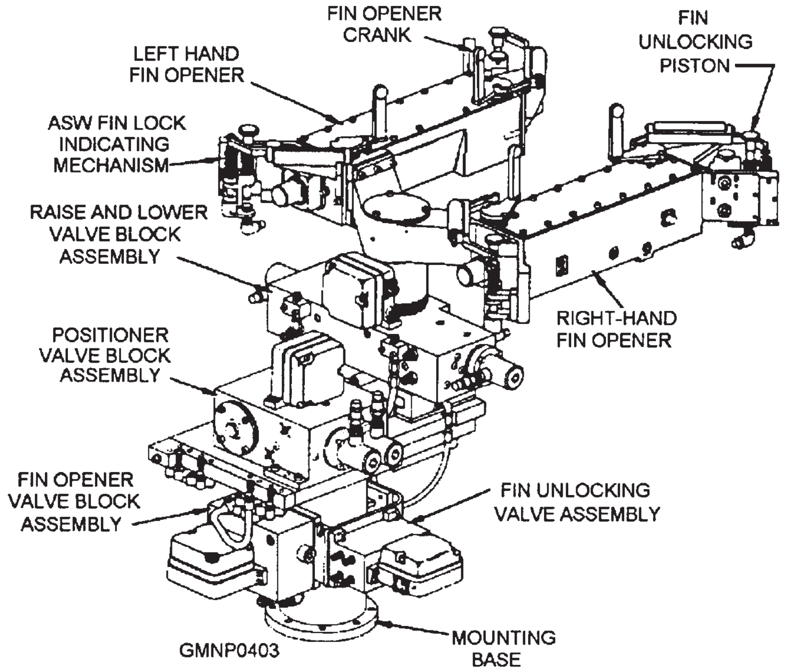


Figure 7-24.—Fin opener assembly.

locks work together to prevent unauthorized loading of nuclear warhead missiles.

Both locks must be locked to perform their intended function. Figure 7-23, view A, shows how the retractable chain track is prevented from aligning with the hanger rail. If the locks are in the conditions displayed in views B, C, and D, hoisting can be accomplished.

One key fits all the rail locks of one RSR, while a different key fits the system nuclear lock. According to nuclear weapon security regulations, the commanding officer or a designated representative (must be a commissioned officer) maintains custody of these keys at all times. To load a nuclear ASROC round, personnel must enter the magazine, prepare the missile, and (according to ship's doctrine) unlock at least one of the locks.

FIXED RAIL.—The fixed rail section is mounted to the top of the RSR's hoist end section. (See figs. 7-19 and 7-22.) This 4-foot rail bridges the gap between a hanger rail and the span rail assembly. All three rails are locked together by hydraulically operated aligning rods extending into appropriate alignment guides.

Fin Opener Assembly

The Mk 26 GMLS fin opener assembly (fig. 7-24) is mounted to the magazine deck at the hoist station. It is somewhat physically comparable to other fin opener arm assemblies. During a load cycle, the entire assembly shifts laterally between two positions, AAW or ASW, if required. This action aligns the fin cranks to the fins on the different diameter missiles. Once in proper position, the assembly then raises to engage the missile, unfolds the fins (of AAW and ASW rounds), and then lowers.

During an unload cycle of an ASW missile, the fin opener assembly raises, unlocks, and refolds the ASW fins. The fins of AAW missiles cannot be automatically refolded. System personnel must enter the magazine and manually close them.

Associated with the fin opener assembly is an AAW identification probe (fig. 7-25). It is located

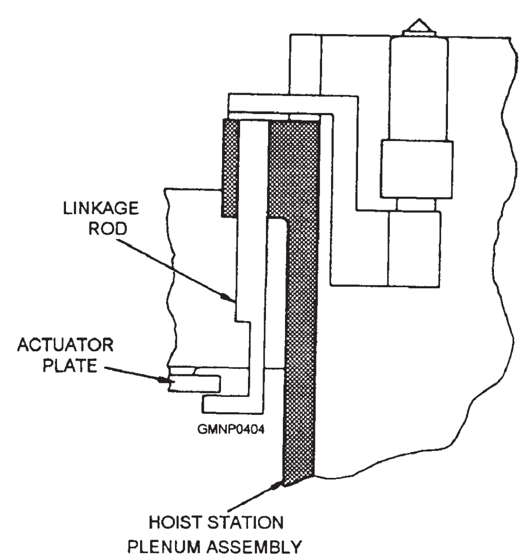


Figure 7-25.—AAW identification probe.

within the inlet of the plenum assembly at the hoist station. The probe is used to identify AAW missile groups before they are hoisted. When the fin opener assembly shifts to the AAW position, an actuator plate on the left-hand opener engages a linkage rod attached to the probe. As the assembly raises (or lowers), the probe also raises (or lowers) to engage (or exit) the aft receptacle of the missile.

Magazine Hydraulic Systems

Within each RSR's six-missile section and hoist end section are the components that produce the necessary hydraulic forces to operate the system during normal and emergency conditions. The principal hydraulic systems are the RSR/hoist main accumulator and power drive system and the exercise and emergency accumulator system.

RSR/HOIST SYSTEM.—Sharing a common electric motor, the RSR/hoist main accumulator system and the RSR/hoist power drive function during all normal GMLS operations. The main accumulator system supplies various hydraulic fluid pressures to operate components of the loading system, the strikedown system, the jettison devices, and the RSR/hoist power drive.

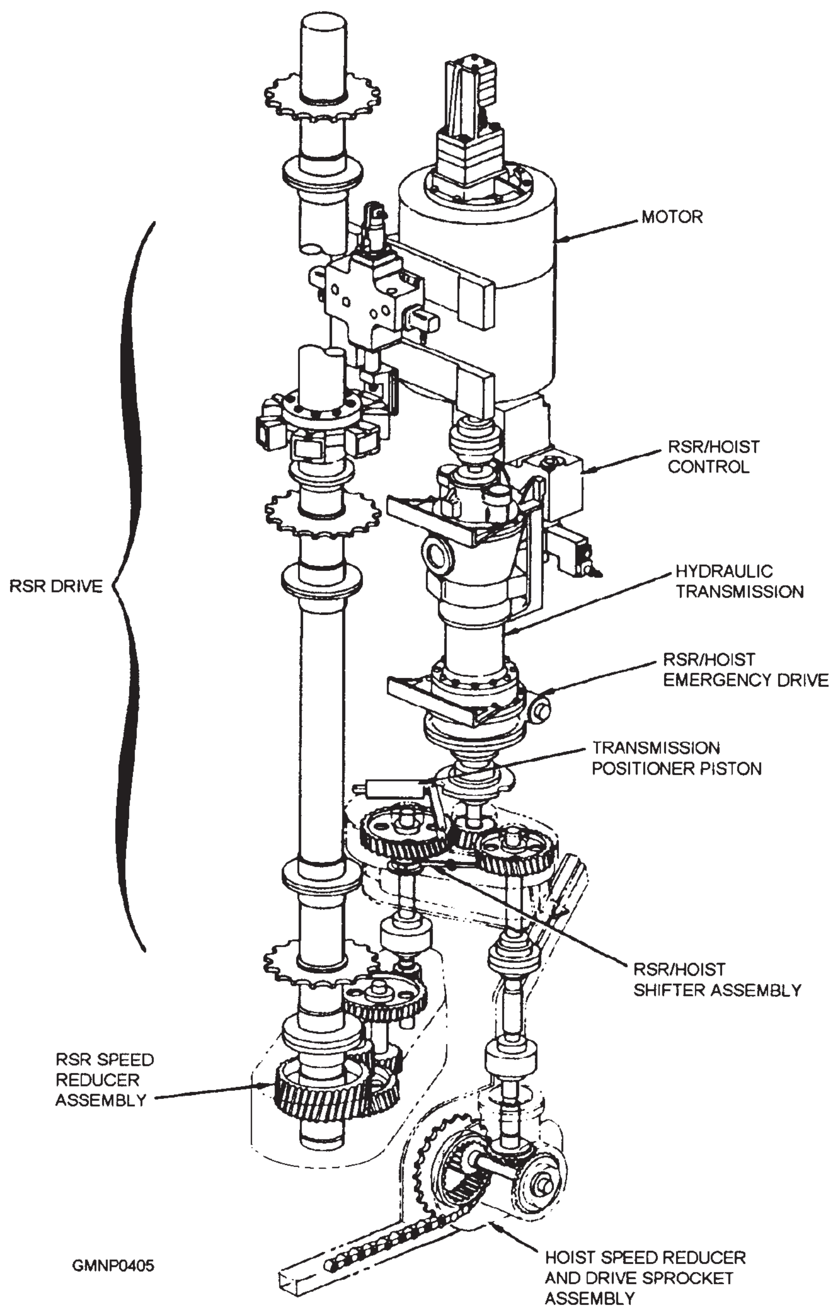


Figure 7-26.—RSR/hoist power drive.

The RSR/hoist power drive (fig. 7-26) provides the hydraulic power and control needed to index the hanger rails and to raise/lower the hoist chain and pawl. A hydraulically operated shifter mechanism transfers the output of the hydraulic transmission to either the RSR speed reducer and drive sprocket or to the hoist speed reducer and drive sprocket. The individual drive trains for the RSR and hoist are shown in figure 7-26.

EXERCISE AND EMERGENCY ACCUMULATOR SYSTEM.—Each RSR contains an exercise and emergency accumulator system. It is used in the event of normal electrical power failure or for exercise/maintenance purposes. This system is hydraulically part of the RSR/hoist main accumulator system. However, it uses a smaller electric motor and pump to deliver a reduced hydraulic fluid pressure to the magazine components and the train power drive.

LAUNCHER

The launcher consists of all the components necessary to receive missiles from the magazine and prepare them for launching. A rectangular plate about 18 feet long and 10 feet wide, called the platform, supports the carriage and two dud-jettison devices. It also provides mounting surfaces for the blast doors, span rails, and some train drive components.

The carriage supports the guide arms and consists of various components, as shown in figure 7-27. The stand is secured to the platform and serves as a stationary support structure. The base ring fits inside the stand and rotates on two sets of bearings. Ball bearings near the top of the stand support the weight of the rotating launcher. Roller bearings near the bottom of the stand hold the base ring in vertical alignment.

The trunnion support is a boxlike structure mounted to the top of the base ring. It supports the trunnion tube on ball- and roller-bearing assemblies. It also houses the elevation drive and other hydraulic components. The electrical contact ring is located within the base ring area. It transmits electrical power and anti-icing fluid between the stationary and rotating parts of the launcher.

Blast Door and Span Rail

A blast door is mounted to the platform under each guide arm. (See fig. 7-17.) In opening, the door unlatches, raises, and swings aside. This provides sufficient clearance for a missile with fins extended to pass through. In closing, the sequence is reversed and a seal on the bottom of the door forms a water- and blast-tight closure.

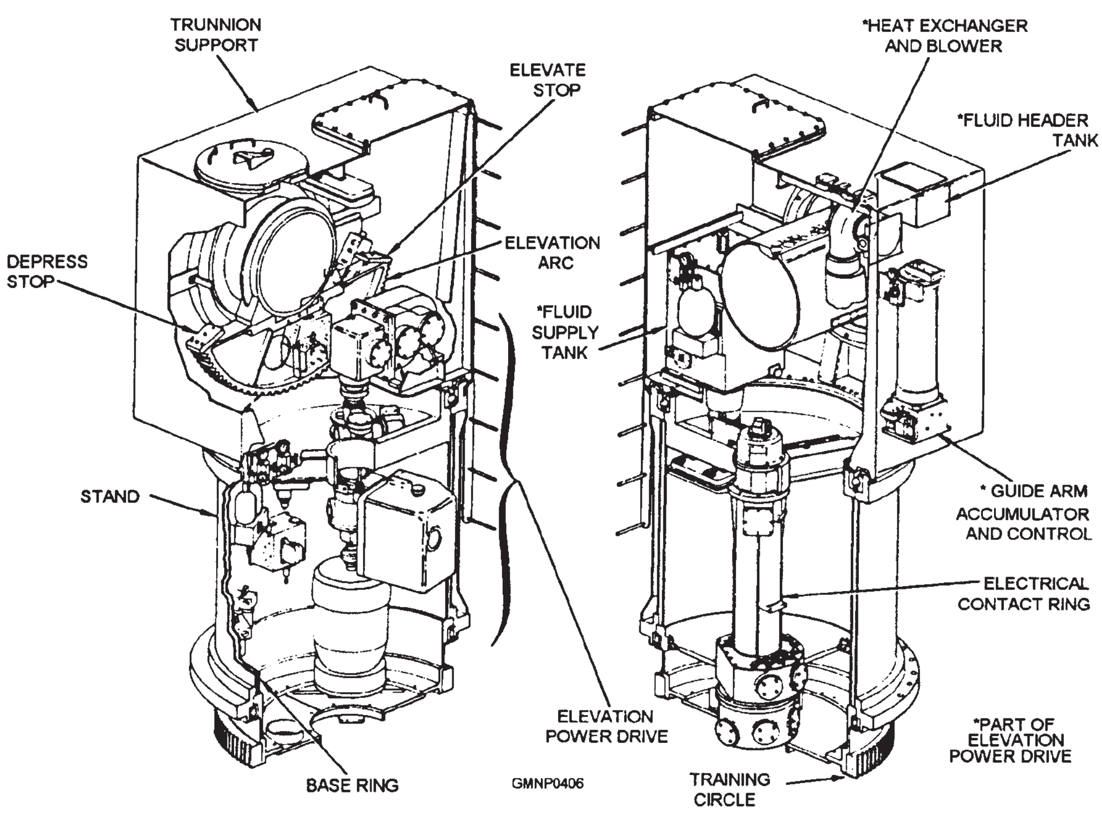


Figure 7-27.—Carriage, general arrangement.

A separate span rail assembly (not part of the blast door) is located inside the door opening. (See fig. 7-22.) It is a pivoting rail segment, about 3 feet long, extended by a hydraulic piston. A bumper pad on the rail contacts the edge of the blast door opening to provide a positive aligning stop. When fully extended, aligning and latch rods lock the span rail to the fixed rail of the guide arm and the fixed rail of the magazine.

Guide Arm

The guide arm structure (fig. 7-28) is a steel weldment with three different guide rails, ASW-related components, and AAW-related components. Depending on the mode (AAW or ASW) in which the system is operating, the applicable equipments connect to and prepare the missile for flight.

GUIDE RAILS.—Of the three individual guide rail sections on each guide arm, two are fixed and one is movable. The total length of the aft fixed rail is about 50 inches. It contains a pair of hinged rail track segments and an overtravel cam. The pivoting segments, about 19 inches long, open and close to form the rail track for the aft shoe of an AAW missile. The overtravel cam accommodates a positioning link on the hoist chain and pawl to allow proper positioning of a missile on the guide rail.

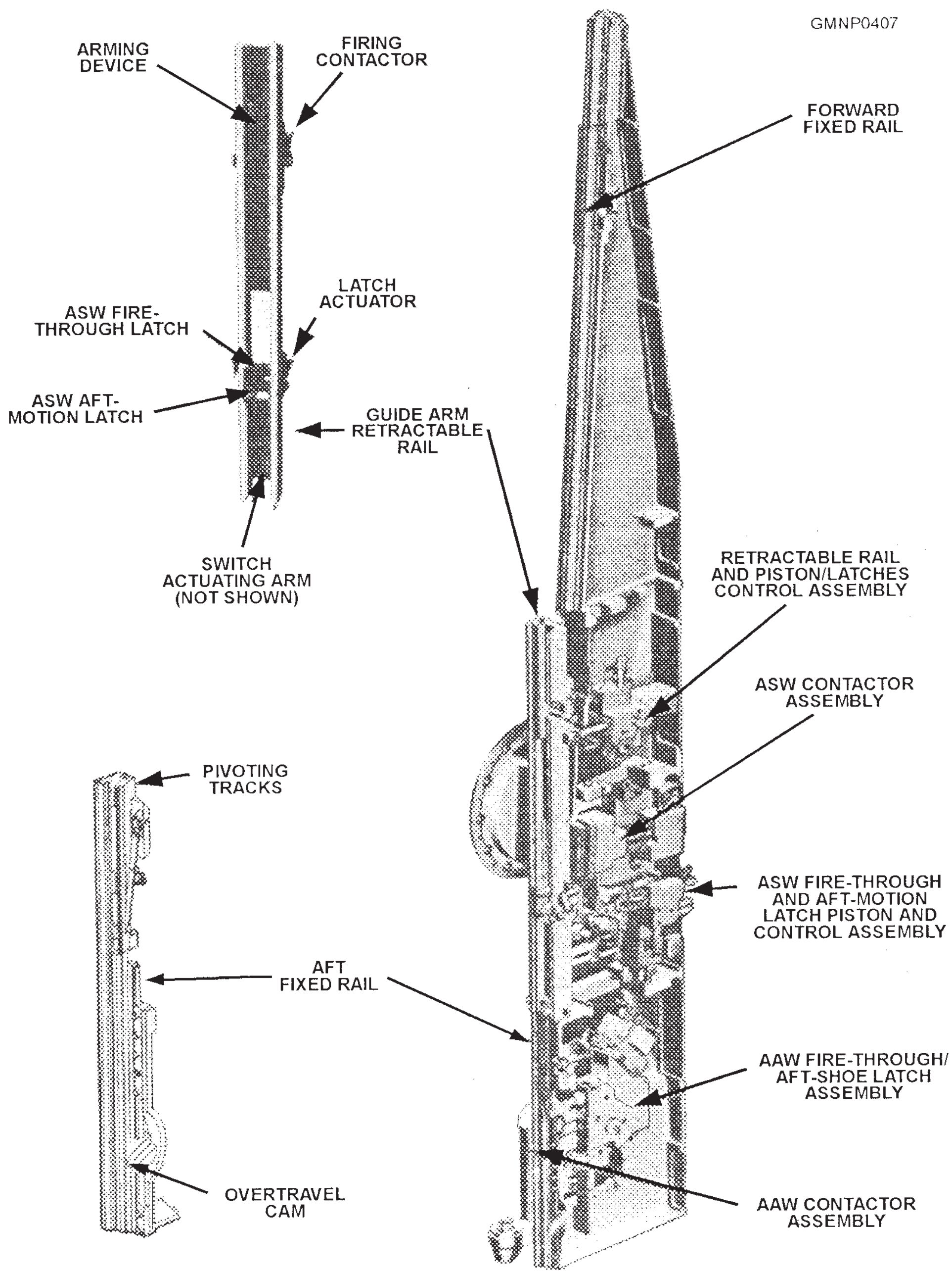


Figure 7-28.—Guide components, general arrangement.

The forward fixed rail is about 11 1/2 feet long and contains no functional components. This rail is used only when firing ASW missiles and provides the longer on-rail guidance required by this type of missile.

The retractable rail is mounted between the two fixed rails and is about 6 1/2 feet long. During a loading operation, it extends to align with the aft fixed rail. This combination forms one continuous rail track for AAW and ASW forward missile shoes. With an AAW missile, the rail remains extended until the round is launched. As the missile moves forward, the rail retracts to clear the fins of the missile. With an ASW missile, the rail retracts as soon as the round is loaded onto the guide arm. It remains retracted to form the longer guidance track with the forward fixed rail.

ASW RAIL COMPONENTS.—There are three different components involved with preparing and launching ASW missiles on the guide arm. The ASW fire-thru and aft-motion latch piston and control assembly operates two of these devices.

The ASW fire-thru latch is extended through the rail to engage the forward edge of the aft missile shoe. As it extends, it causes the ASW aft shoe restraining latch (on the pusher bar) to release. During firing, the fire-thru latch holds the ASW missile on the rail until about 2,600 pounds of thrust is developed by the rocket motor and then it trips (releases).

The ASW aft-motion latch is extended by the same assembly to engage the rear edge of the aft missile shoe. It secures the missile to the rail and allows the pusher bar and hoist chain to retract to the magazine.

The third component is the ASW contactor assembly (fig. 7-29). When it extends, the contactor pins penetrate a pad near the aft shoe of the missile. Electrical power, preflight data, and firing voltages are transmitted through this connection from UBFCS and WCS to circuits within the missile. At firing, the contactor retracts into the guide arm.

AAW RAIL COMPONENTS.—The rail components required to load, prepare, and launch AAW missiles involve three separate (and more complicated) assemblies. Located above the aft fixed rail, the AAW fire-thru and aft-motion latch assembly (see fig. 7-28) is functionally similar to its ASW counterpart. The AAW fire-thru latch trips from 4,000 to 4,600 pounds. The AAW aft-motion latch extends to release the AAW aft-shoe-restraining latch (on the pusher bar) to secure the missile to the rail.

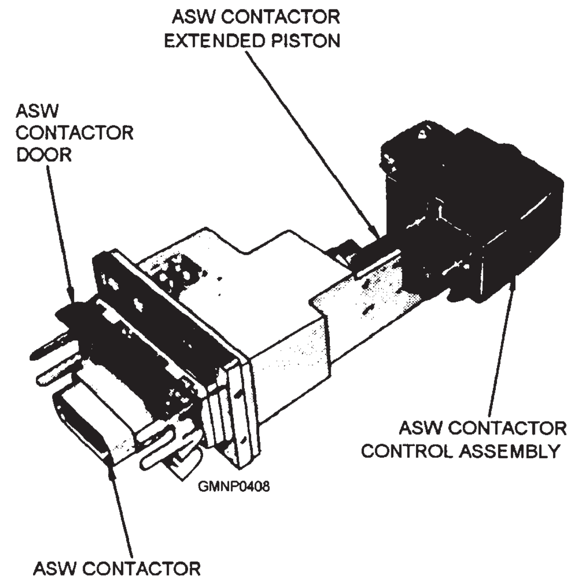


Figure 7-29.—ASW contactor assembly.

The two hinged-rail segments (mentioned earlier on the aft fixed rail) operate with the aft-motion latch linkage. When an AAW missile is loaded to the rail, the segments are open to accept the missile. As the aft-motion latch extends, mechanical linkages cause the segments to pivot closed, engaging the aft missile shoe. In this position, the segments prevent any lateral movement of the missile. They also provide a short on-rail guidance track. After firing or during unloading, whenever the aft-motion latch retracts, the segments pivot open to release the shoes.

A blast shield also operates with the aft-motion latch linkage. The shield extends with the latch. In this position, it can protect the mechanism from launch sequence, rocket firing voltage is applied, and the motor ignites.

Launcher Hydraulic Systems

There are three hydraulic systems associated with the launcher. They provide all the necessary hydraulic forces required to train, elevate, depress, and operate the guide arm components.

The train power drive system is located under the launcher platform. It drives the launcher through the training circle gear mounted to the base ring.

The elevation power drive system is located inside the carriage. It drives the guide arms through the elevation arc mounted to the trunnion tube. In addition to elevating or depressing the guide arms, the elevation power drive system provides the main accumulator pressure for the guide arm components. Figure 7-27 shows the location of the elevation power drive and the guide arm accumulator and control assembly.

The third hydraulic system is the launcher exercise and emergency accumulator system. (It is very similar to the exercise and emergency accumulator systems described with the RSR/hoist power drives.) This system is hydraulically connected to the elevation power drive system. Hydraulic fluid at reduced pressure is supplied to operate the guide arm components and the elevation power drive.

LAUNCHING SYSTEM CONTROL

The launching system control components perform three main functions: (1) They distribute electrical power, (2) they process system orders and responses, and (3) they perform tests to determine system readiness. As you study the Mk 26 GMLS control system, you will notice a break with tradition. Panels are no longer designated EP1, EP2, and so on, but are known by their full name or first-letter abbreviations.

Most communications and interface between weapons control, FCS, and the GMLS are in digital word format. (There may be some terms presented here with which you are not yet familiar, but they will be explained later in the text.) Although not physically located in the GMLS area, the digital serial transceiver (DST) (shown in fig. 7-18) is a solid-state electronic module in the weapons control area. It serves as a communication link between WC and launching system control. This module receives parallel order data (electrical signals) from a computer in WC. It changes the order data from parallel to serial form for transmission to the ICS through cables. One cable connects to the digital interface module (DIM) and the other to the local control module. The order data signals direct launching system operations in remote control.

The DST also provides response data from launching system control to WC. The DST receives serial response data from the local control module on cables. It changes these data from serial to parallel form. In parallel form, these data are in the correct format for transmission to the WC computer. The response data show the status of the launching system.

Integrated Control Station (ICS)

The integrated control station (ICS) (fig. 7-30), located at the hoist end of the magazine, is a water- and

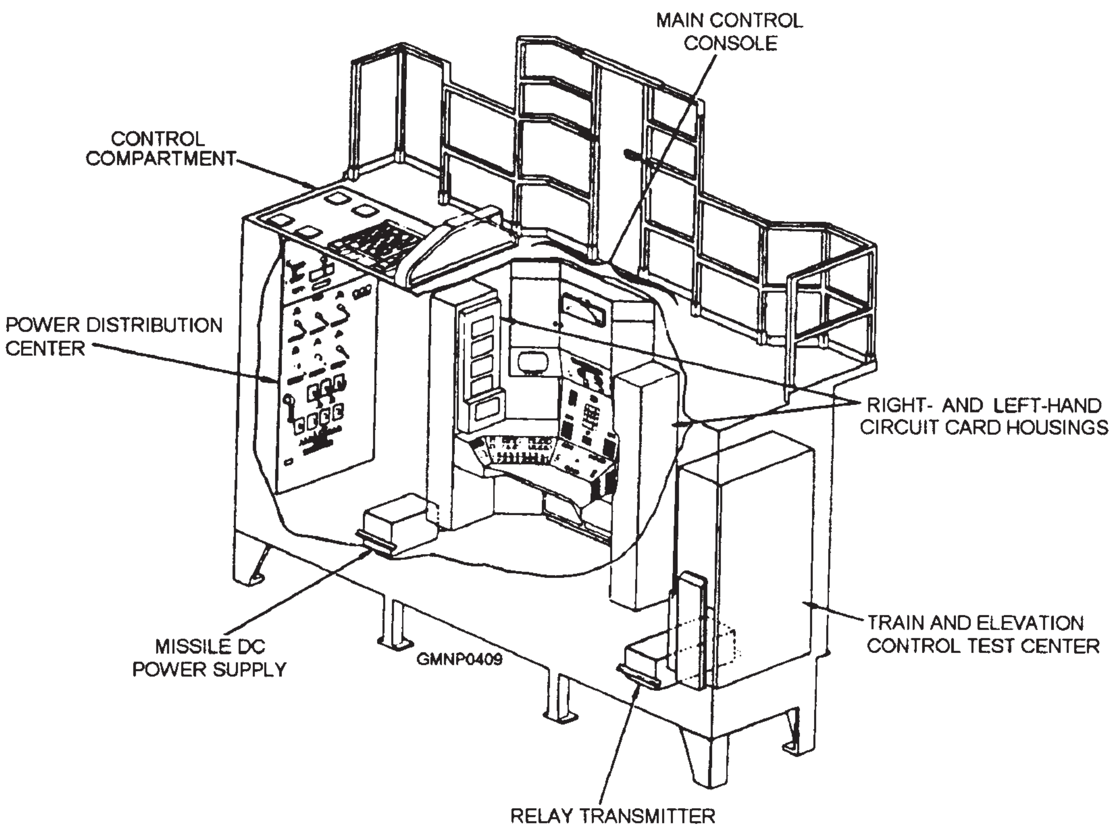


Figure 7-30.—Integrated control station.

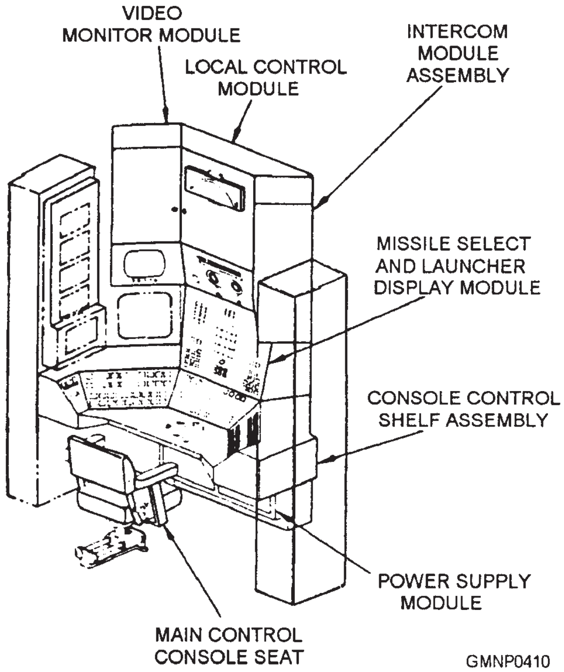


Figure 7-31.—Main control console.

blast-tight compartment. It houses most of the power, control, monitoring, and test equipments of the system. The major cabinets in the ICS are the power distribution center (PDC), the MCC, the right- and left-hand circuit card housings, and the train and elevation control test center.

POWER DISTRIBUTION CENTER (PDC).—PDC houses the electrical components that distribute and regulate all power to the launching system. It is comparable to other EP1 power panels.

MAIN CONTROL CONSOLE (MCC).—The MCC (fig. 7-31) is a modular, wraparound type of unit. It contains the operating controls and indicators needed for programming and monitoring launching system operations. The individual modules in the MCC are shown in separate figures for clarity.

The video monitor module (fig. 7-32, view A) consists of electrical components and a TV screen used for watching either the launcher area or rear magazine areas.

The local control module (fig. 7-32, view B) is used by the MCC operator as the local control station for the train and elevation power drives. Also provided are a firing safety switch, rail and system nuclear lock indications, and digital readout displays of both launcher ordered and actual positions. This module acts as a communication link between the DST and other ICS equipments.

The intercom module assembly (fig. 7-32, view C) has a 20-station intercom to other parts of the ship. A small compartment can store a set of sound-powered phones for the MCC operator (plus a deck of cards, favorite magazines, and the latest copy of the GM training manual).

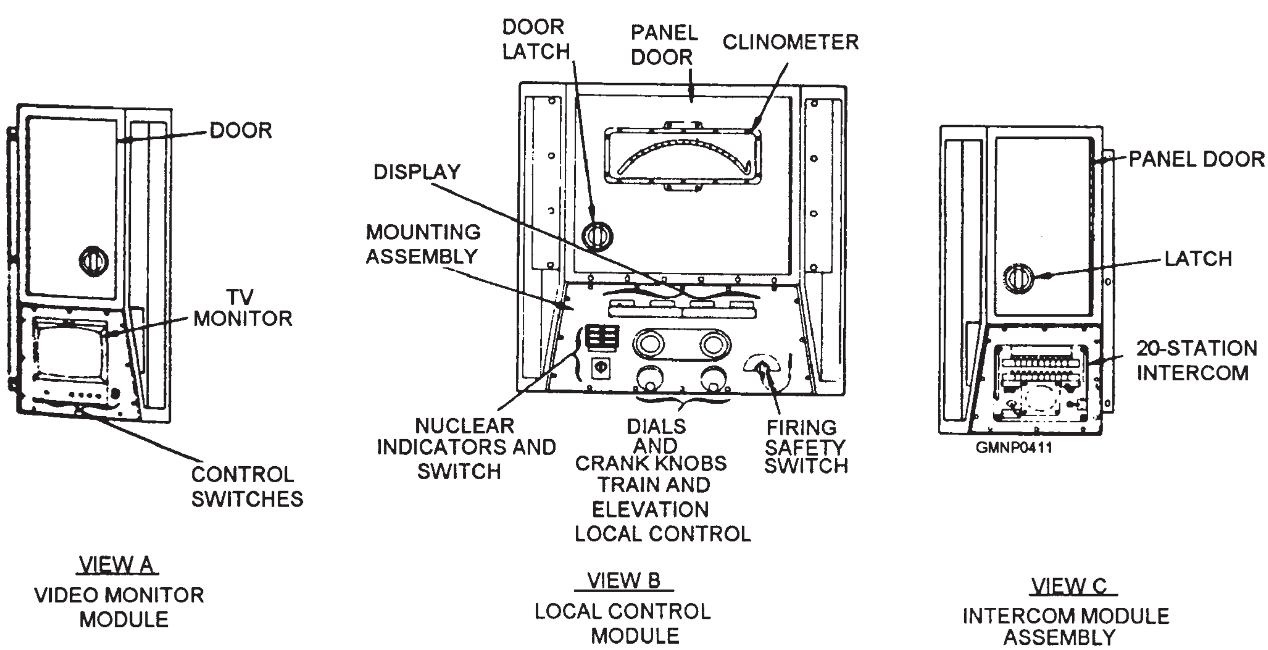


Figure 7-32.—Main control console modules.

The missile select and launcher display module (fig. 7-33) has a variety of switches and indicators used by the MCC operator during remote and local control modes. When the system is operating in remote control, the operator monitors the indicators that show the status of power drives, remote WC orders, and load-and-fire operations. When the launching system is operating in local control, the operator selects the type of missile, a load (or unload) operation, and either one or both launcher guide arms and RSR/hoist equipment.

The console control shelf assembly is directly in front of the MCC operator's chair. It provides a horizontal working space and mounts five separate modules. They will be described left to right.

The system availability module (fig. 7-34, view A) contains push-button indicating and toggle switches. They are used to tell WC of launching system availability status and to select various test modes.

The strikedown step module (fig. 7-34, view B) contains the strikedown hatch, emergency motor, main motor, and strikedown step control push-button indicating switches.

The system control module (fig. 7-34, view C) contains the all motors start/stop, loading selection,

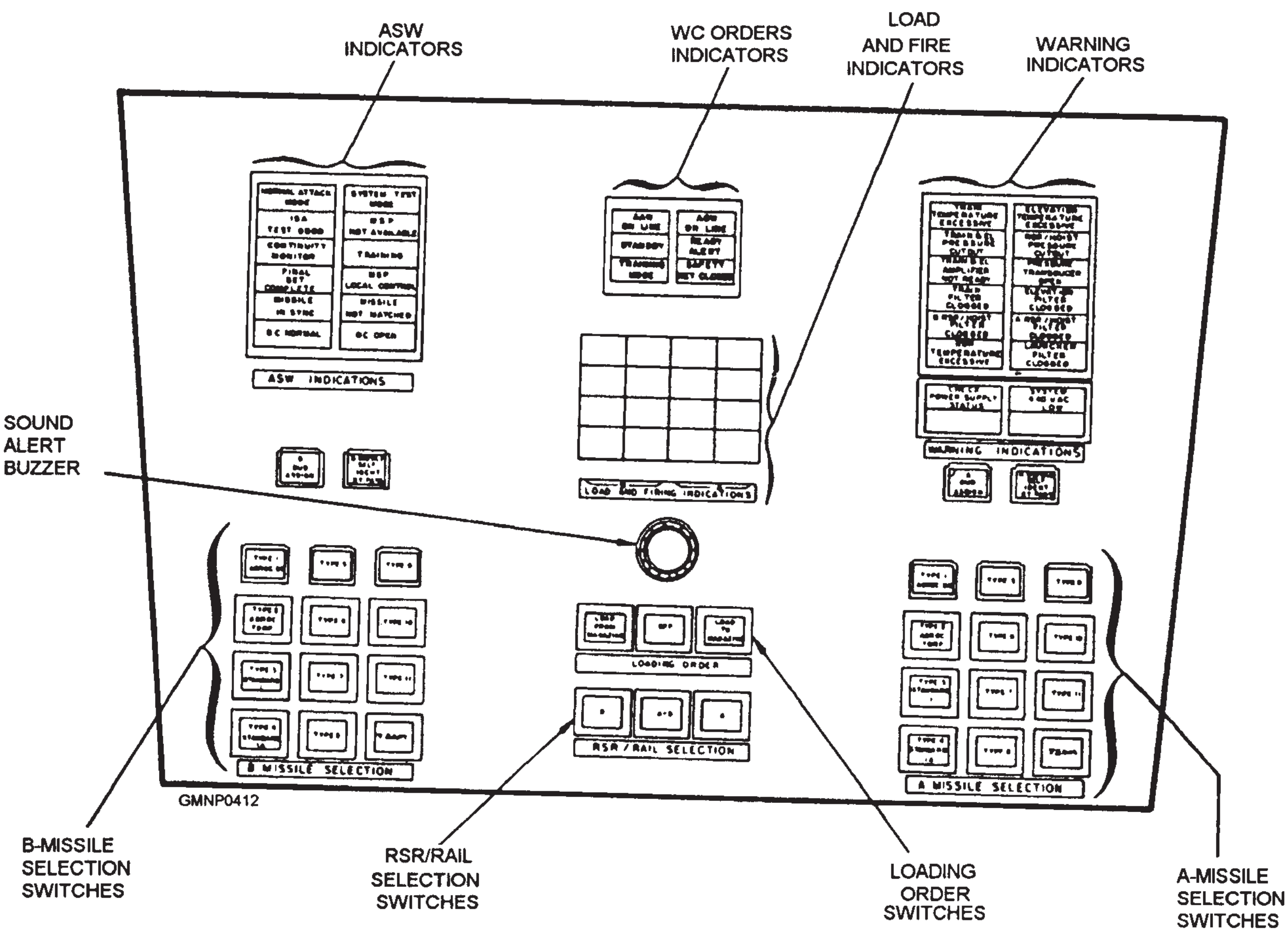


Figure 7-33.—Missile select and launcher display module.

pointing selection, magazine safety, launcher warning bell, and system selection groups of switches.

The launcher step module (fig. 7-34, view D) contains the launcher step control, jettison, and launcher emergency drive groups of switches. This module provides the controls and indicators for performing and monitoring load and jettison operations and for directing the launcher using the emergency motors.

The telephone selector module (fig. 7-34, view E) has two rotary switches and a telephone jack. The load and firing indications lamp test switch is a 13-position rotary switch. The MCC operator uses this switch to test the load-and-fire indicator lamps in the missile select and launcher display module. The telephone selector switch is a six-position rotary switch. The MCC operator positions this switch to select telephone channels to communicate with either WC or local launching system sound-powered phones.

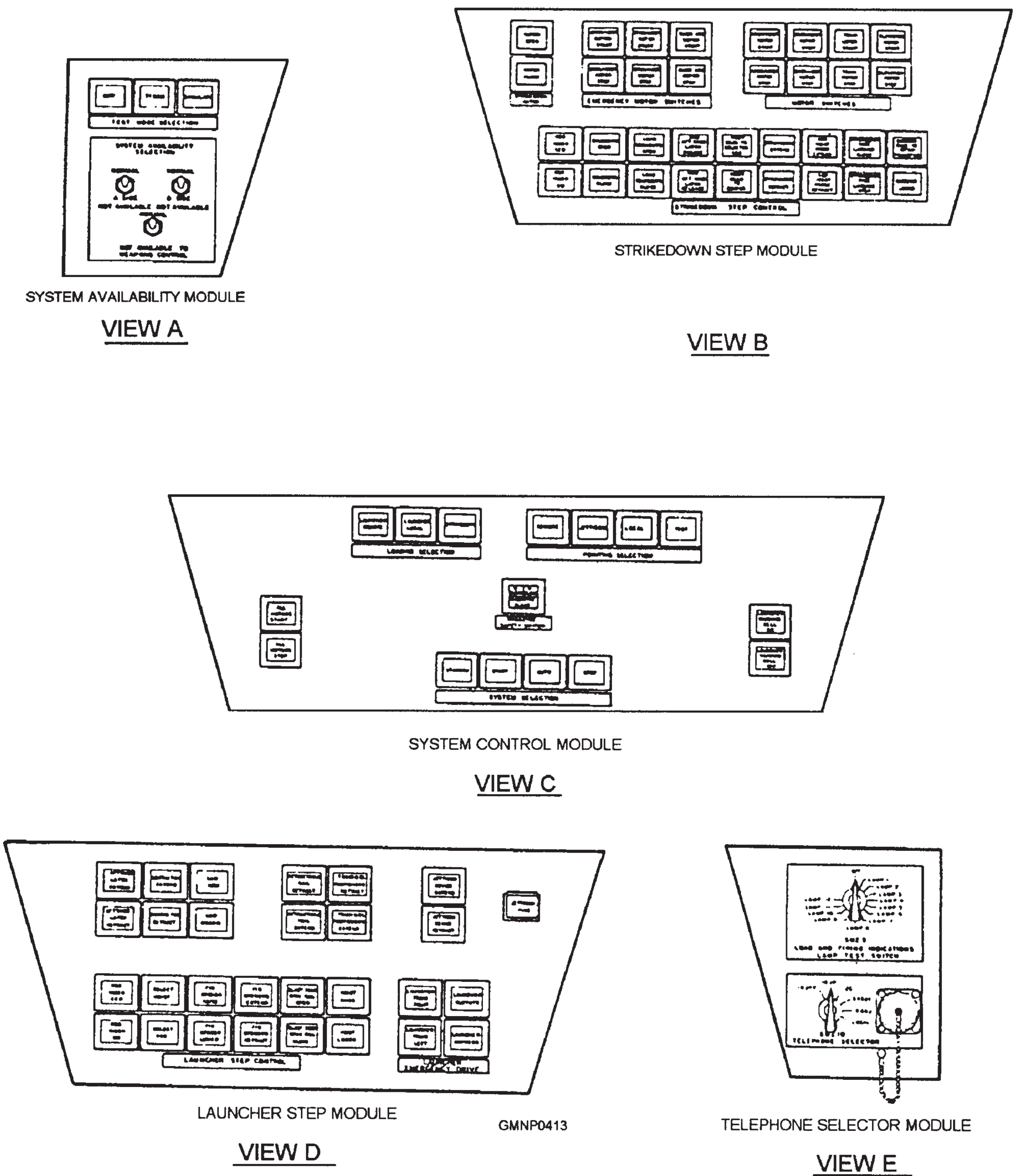


Figure 7-34.—Console control shelf assembly modules.

The last component of the MCC is the power supply module (fig. 7-35). Electrical receptacles on the bottom of the module connect it to the PDC. The components of the module provide regulated dc power to solenoids and solid-state circuits throughout the system. Many of the various rated dc-power supplies are identical, interchangeable, and adjustable.

RIGHT- AND LEFT-HAND CIRCUIT CARD HOUSINGS.—The right- and left-hand circuit card housings (fig. 7-36) are on either side of the MCC. These housings contain the electrical/electronic components used for system control. The two housings are arranged the same but show different information. The right-hand circuit card housing shows A-side, train, and elevation system status. The left-hand circuit card housing shows B-side and strikedown system status.

TRAIN AND ELEVATION CONTROL TEST CENTER.—The train and elevation control test center (fig. 7-37) is mounted on the right bulkhead of the control compartment. It houses launching system test equipment, a DIM, and an ESCU.

Launching system test equipment is on the upper two shelves of the train and elevation control. The test equipment is used for programming and signal tracing of train and elevation components. Operating cycles of the launching system may be timed and proximity switch actuators may be tested and charged. The elapsed running time of motors, control system, and strikedown equipment, along with the cumulative number of RSR index and raise hoist cycles, are monitored. The equipment is also used for programming and testing integrated circuit components.

The DIM is a solid-state electronic control module. It provides train and elevation analog signals to the train and elevation control and to the ESCU. Inside the DIM are PC cards that accept either a remote, test, load, or jettison order signal. The signal depends on the pointing mode selected at the MCC. In remote mode, the PC cards accept serial order data from the DST or—on an alternate path—the same serial order data from the local control module (view B in fig. 7-32).

The PC cards change the serial order data to two analog signals: a synchro position order and a velocity order. The synchro position order causes the train and elevation control to position the launcher. The velocity order allows the ESCU to compensate the train and elevation control.

The PC cards process test orders the same way as remote orders, except that the order signal generator (OSG) provides the serial order data. For load or jettison mode, a diode pinboard in the DIM generates fixed-position signals. These signals allow the PC cards to generate the desired position.

The ESCU is the servo amplifier for train and elevation control. The PC cards inside the ESCU generate command signals that cause the train and elevation power drives to move the launcher to an ordered position. The PC cards give command signals by processing analog synchro pointing orders from the DIM and comparing these orders to the actual position of the launcher. The actual launcher position is

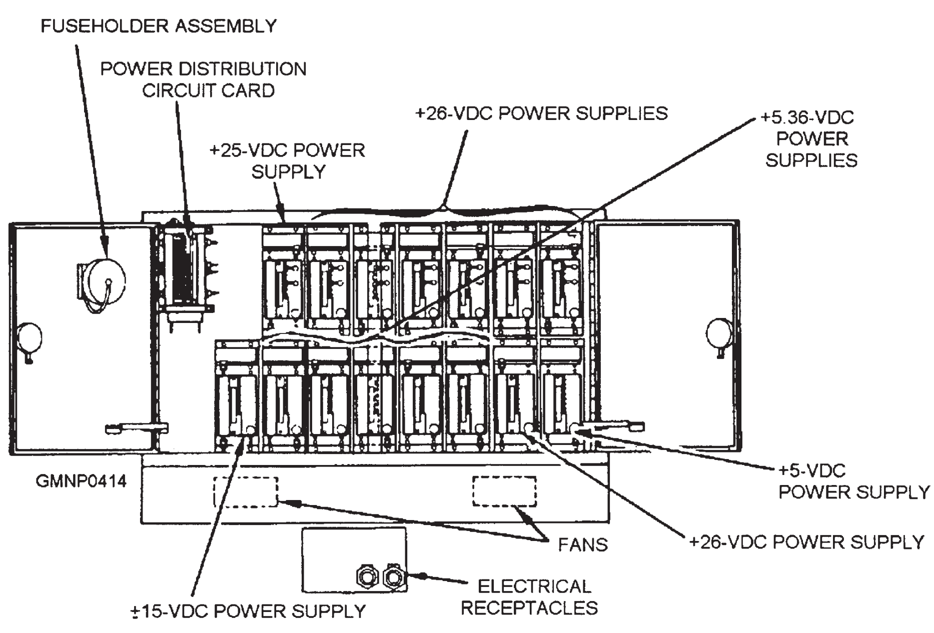
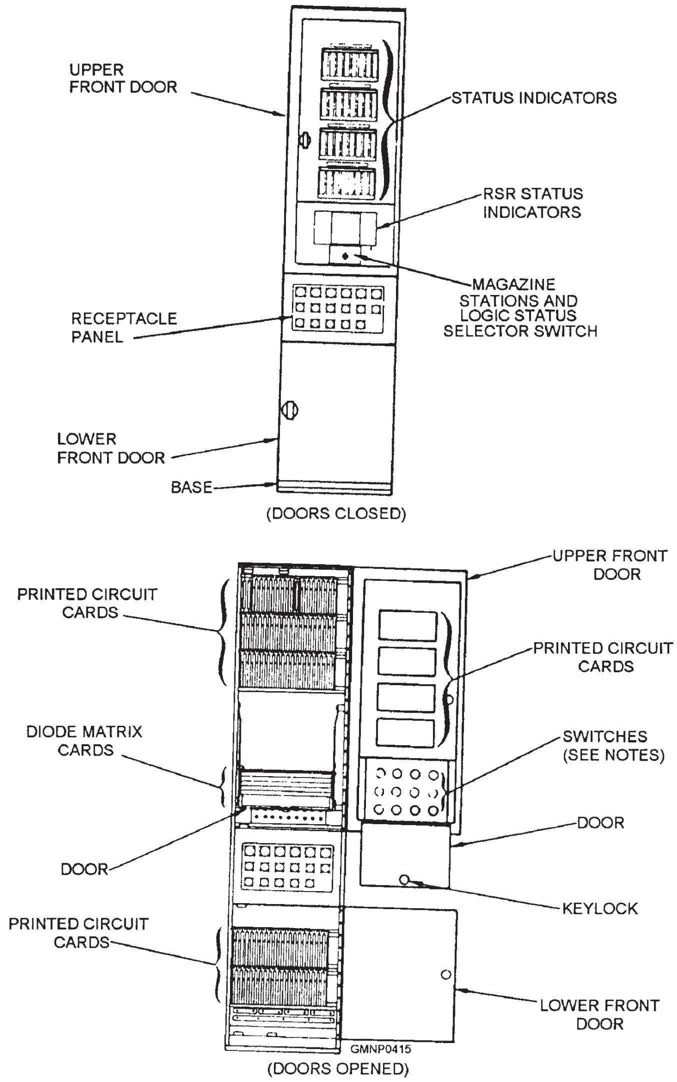


Figure 7-35.—Power supply module.



NOTE: MOD 0 HAS 12 MISSILE TYPE ASSIGNMENT SWITCHES.
MOD 1 HAS 22 MISSILE TYPE ASSIGNMENT SWITCHES.
MOD 2 HAS 32 MISSILE TYPE ASSIGNMENT SWITCHES.

Figure 7-36.—Circuit card housings, typical.

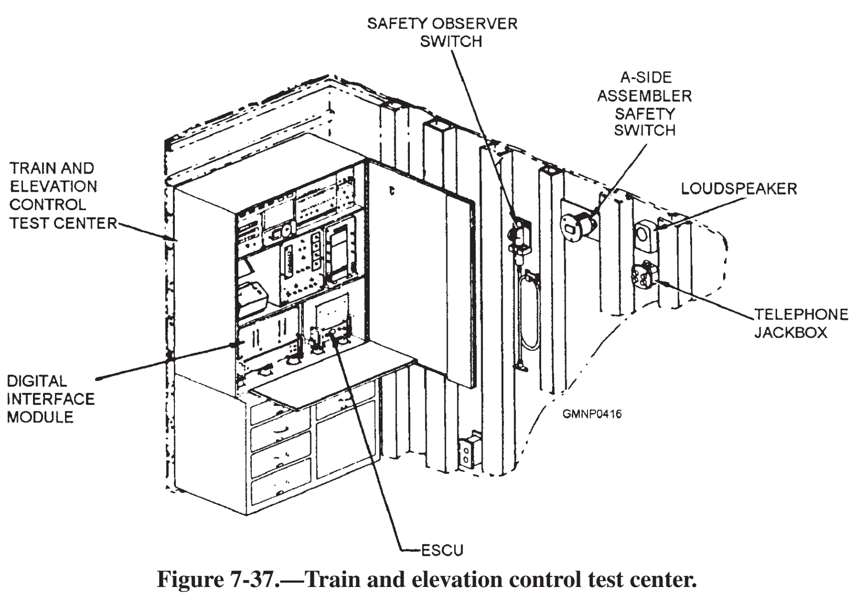


Figure 7-37.—Train and elevation control test center.

provided to the ESCU by feedback signals from train and elevation controls.

Auxiliary Equipments

Located on top of the ICS compartment are other components not directly associated with the control system, but they do bear mentioning.

The personnel access trunk (fig. 7-38) serves as a passageway connecting the ship security station to the ICS. It also mounts various weapons system-related electrical and electronic equipments. Interconnecting cabling from WC and ship's power enter the trunk and are routed to a receptacle assembly. The cables are then attached to quick-disconnect plugs and routed to the ICS.

A filter box assembly has components that filter 115-volt ac, 400-Hertz synchro power and the 28-volt dc power for firing circuits. A channel selector (not part of the launching system) contains components used to match the frequency of the AAW missile on the launcher rail to the radar channel frequency of the fire control system.

An ASW-missile setting panel (also not part of the launching system) contains electrical and electronic equipment used for programming ASW missiles. The thermal battery compartment (shown in fig. 7-18) stores 15 ASROC missile (depth charge) thermal batteries. A battery is installed manually in the weapon before it is loaded onto a guide arm. The compartment has two doors and a combination lock.

MK 41 VERTICAL LAUNCHING SYSTEM (VLS)

LEARNING OBJECTIVES: Explain the purpose/function of the Mk 41 vertical launching system (VLS). Identify the major components and Mod differences of the VLS.

We will now discuss the physical and functional characteristics of the Mk 41 Mods 0, 1, and 2 VLSs. The Mk 41 Mod 0 VLS is used with the AEGIS,

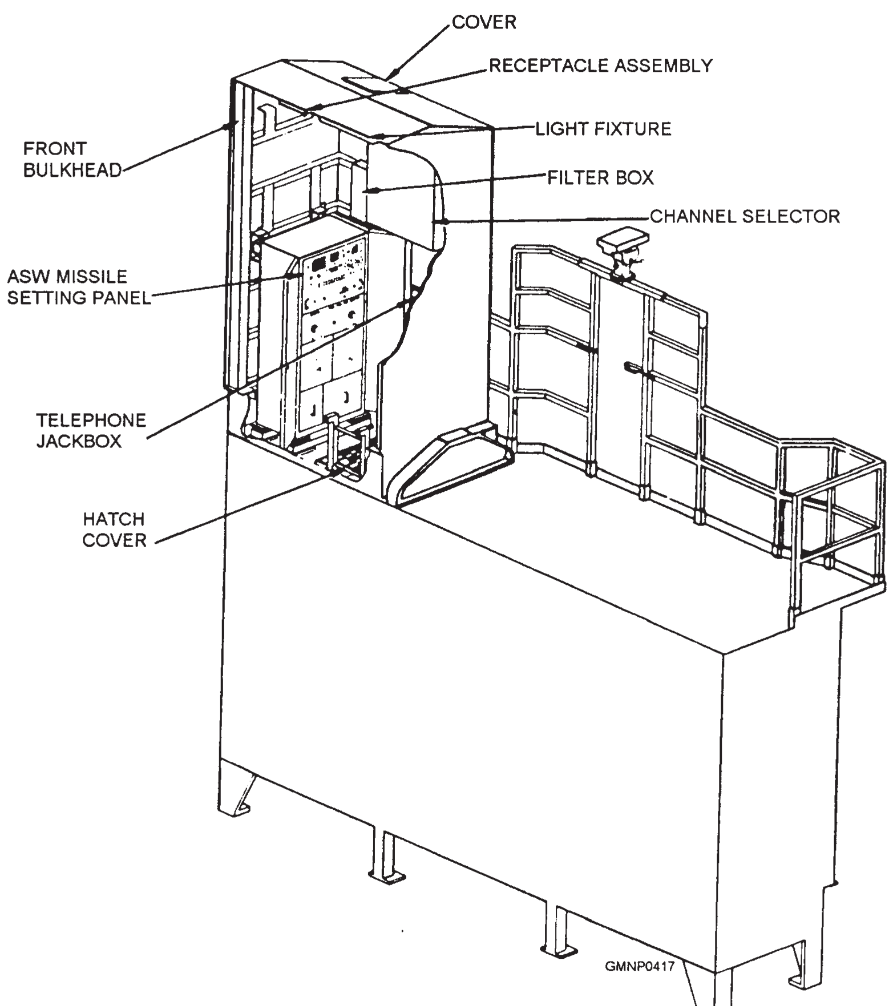


Figure 7-38.—Personnel access trunk.

Tomahawk, and underwater weapon systems onboard CG-47 and CG-52 and up class ships. The Mk 41 Mod 1 is used with the Tomahawk and underwater weapon systems onboard DD-963 class ships. The Mk 41 Mod 2 is used with the AEGIS, Tomahawk, and underwater weapon systems onboard DDG-51 class ships.

DESCRIPTION AND CAPABILITIES

The VLS (figs. 7-39, 7-40, and 7-41) is a multipurpose launching system that can load/accept, stow, select, prepare for launch, and launch the Standard missile Type 2 (SM-2), the Tomahawk cruise missiles, and the vertical launch antisubmarine rocket (ASROC VLA) against air, surface, land, or subsurface targets.

The missiles are contained in separate sealed canisters that are installed vertically below deck in individual cells of a vertical launcher. The Mk 41 Mod 0 VLS on CG-47 and -52 and up class ships has both a forward and aft launcher with 61 cells in each. The

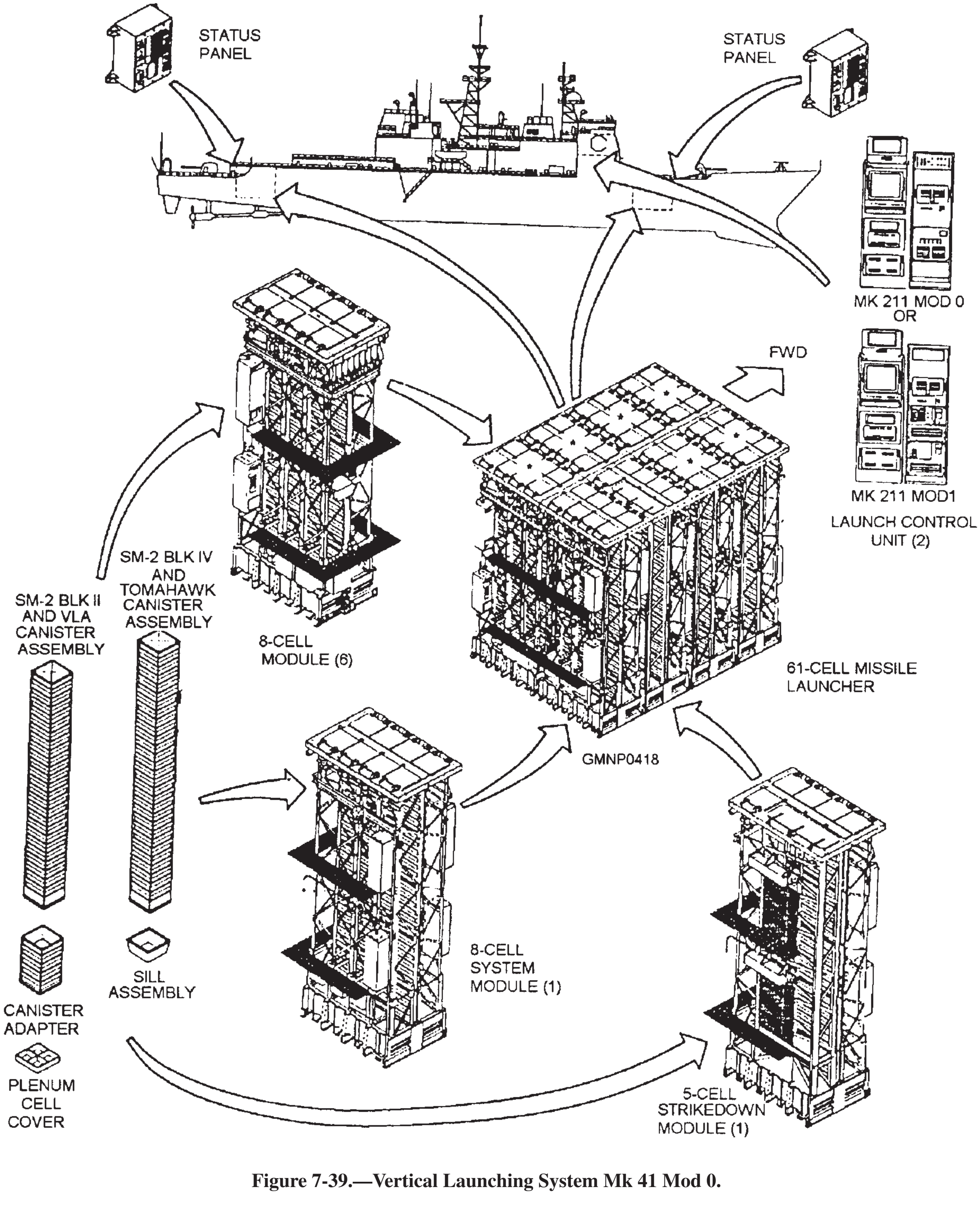


Figure 7-39.—Vertical Launching System Mk 41 Mod 0.

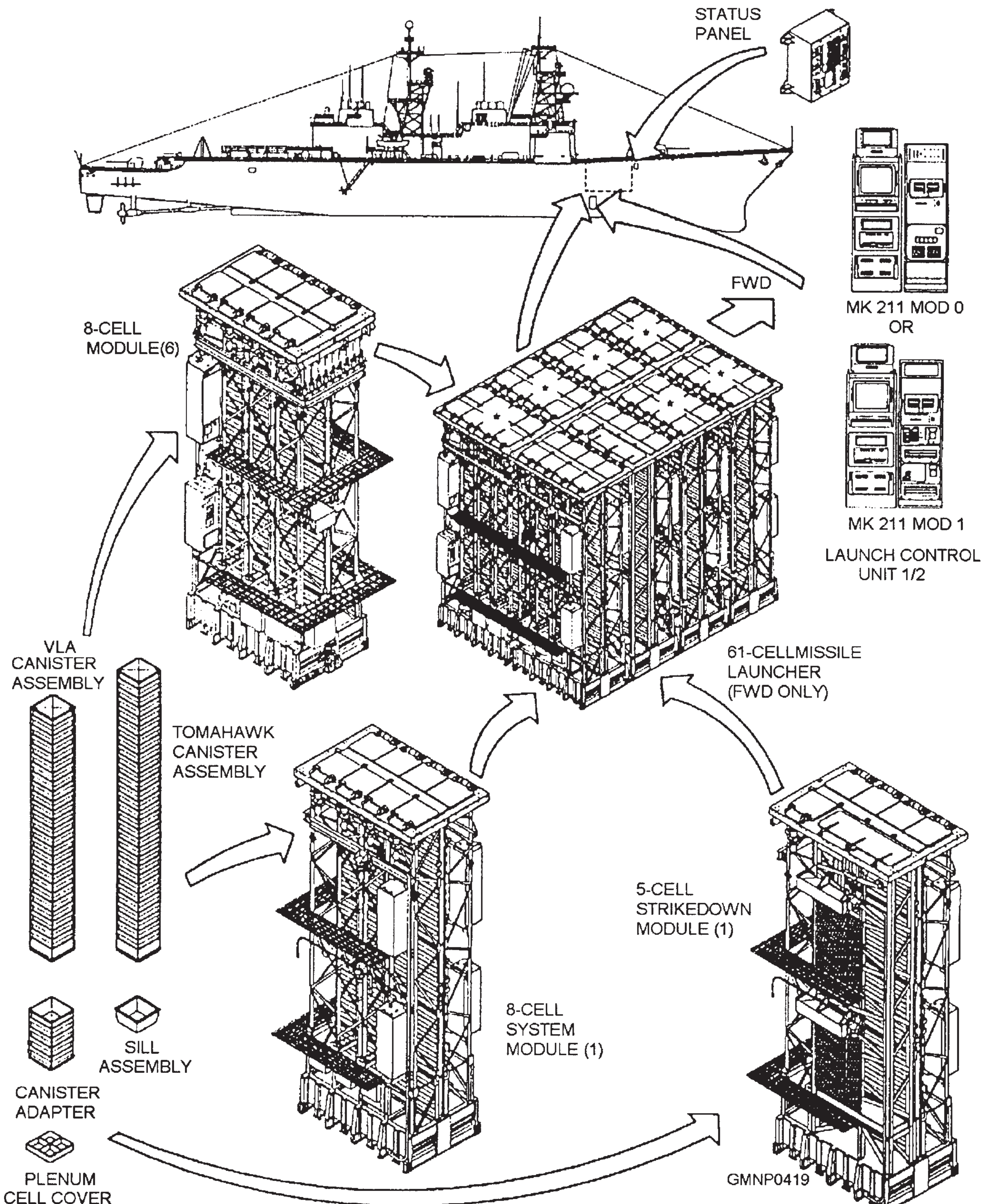


Figure 7-40.—Vertical Launching System Mk 41 Mod 1.

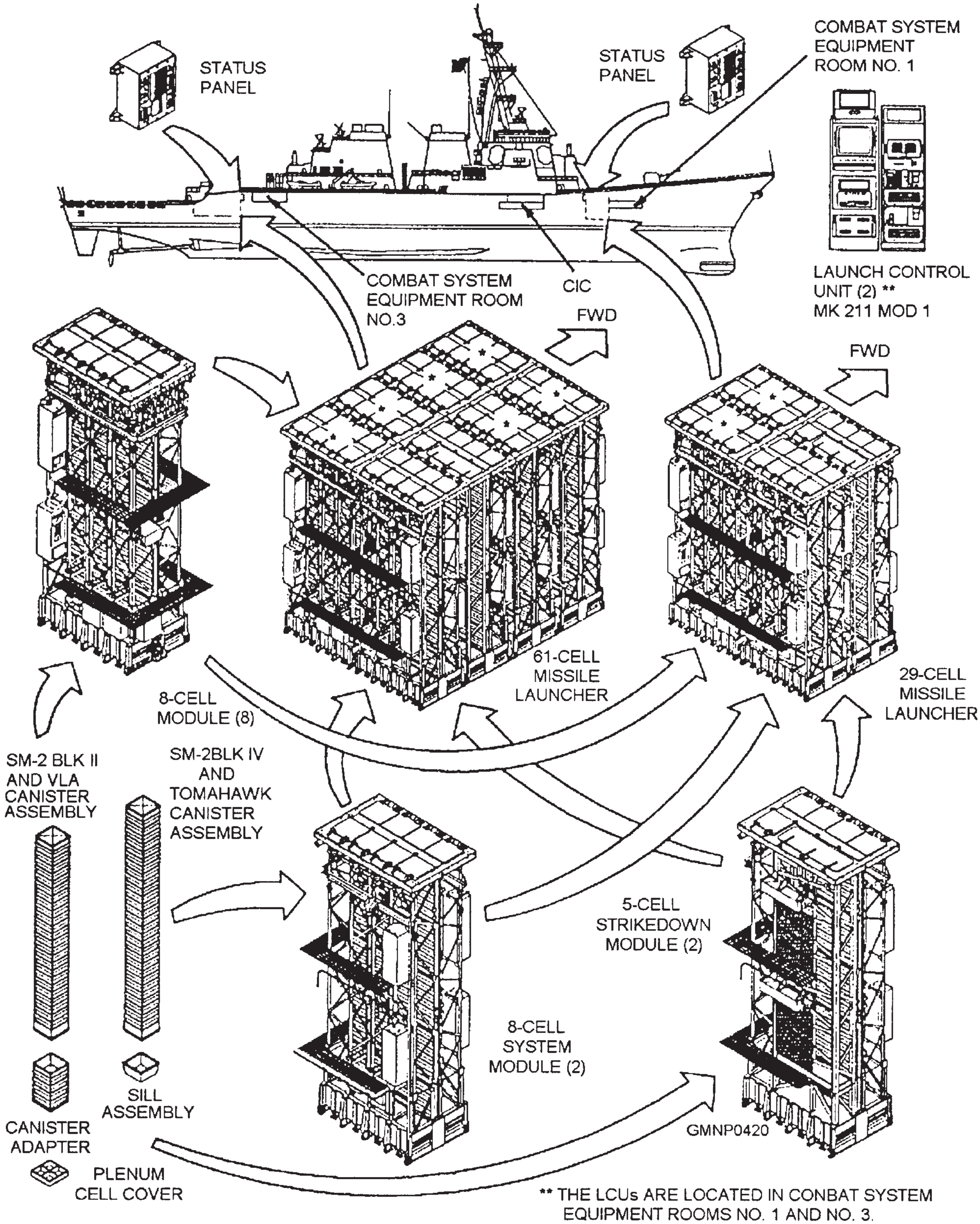


Figure 7-41.—Vertical Launching System Mk 41 Mod 2.

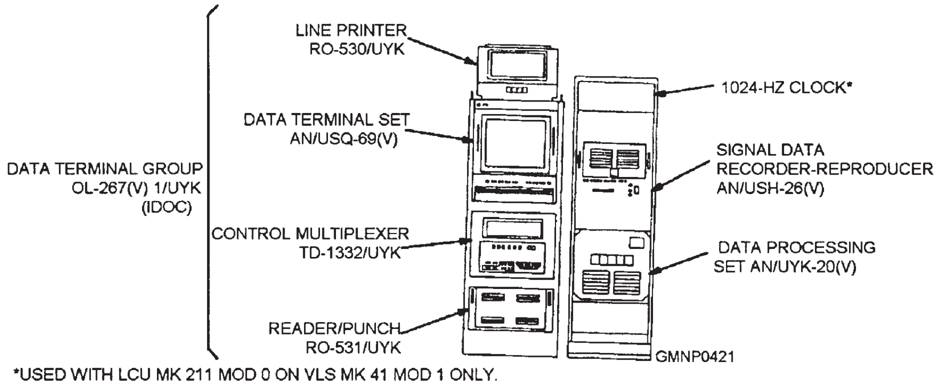


Figure 7-42.—Launcher control unit Mk 211 Mod 0.

Mk 41 Mod 1 VLS on DD-963 class ships has a single, forward 61-cell launcher. The Mk 41 Mod 2 VLS on DDG-51 class ships has an aft launcher with 61 cells and a forward launcher with 29 cells.

LAUNCHER CONTROL UNITS (LCUs)

Each Mk 41 VLS contains two launcher control units (LCU 1 and LCU 2), Mk 211 Mod 0 or Mk 211 Mod 1 (figs. 7-42 and 7-43), depending on the class and the equipment installed. The LCUs interface with the ship's WCSs, manage VLS operations, and interface with VLS weapons for hazard monitoring and to select, prepare, and launch missiles. Each LCU is capable of controlling all missiles in either launcher. They maintain simultaneous communications with the WCSs and each other.

Status Panel

The status panel Mk 416 Mod 0 or Mk 430 Mod 0 monitors hazards and continuous power, controls launcher power, enables strikedown and anti-icing, and provides the launcher hazard status to the combat systems maintenance control or damage control center. The status panel maintains communication with the remote launcher enable panel (RLEP) in CIC for remote control of the magazine power and launch enable. The panel also includes a relay that is controlled by the safety observer's safety switch during strikedown operations.

Remote Launch Enable Panel (RLEP)

The RLEP, located in CIC, interfaces with the status panel to provide control of the remote magazine power and remote launch enable signals to the launcher. The Mk 428 Mod 0 RLEP is a double panel with one side for the forward launcher and an identical side for the aft launcher. The Mk 441 Mod 0 and 1 RLEP is a single panel for controlling one VLS launcher.

VERTICAL LAUNCHERS

There are two types of launchers associated with the VLS—the Mk 158 Mod 0, which is a 61-cell launcher, and the Mk 159 Mod 0, which is a 29-cell launcher (figs. 7-44 and 7-45). The launchers are

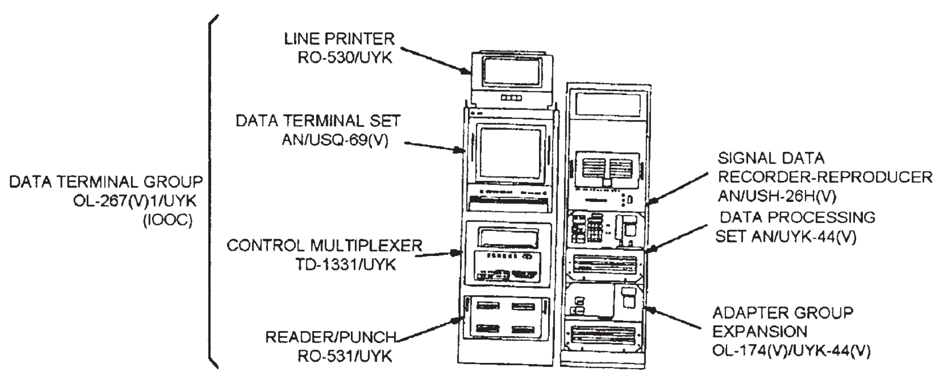


Figure 7-43.—Launcher control unit Mk 211 Mod 1.

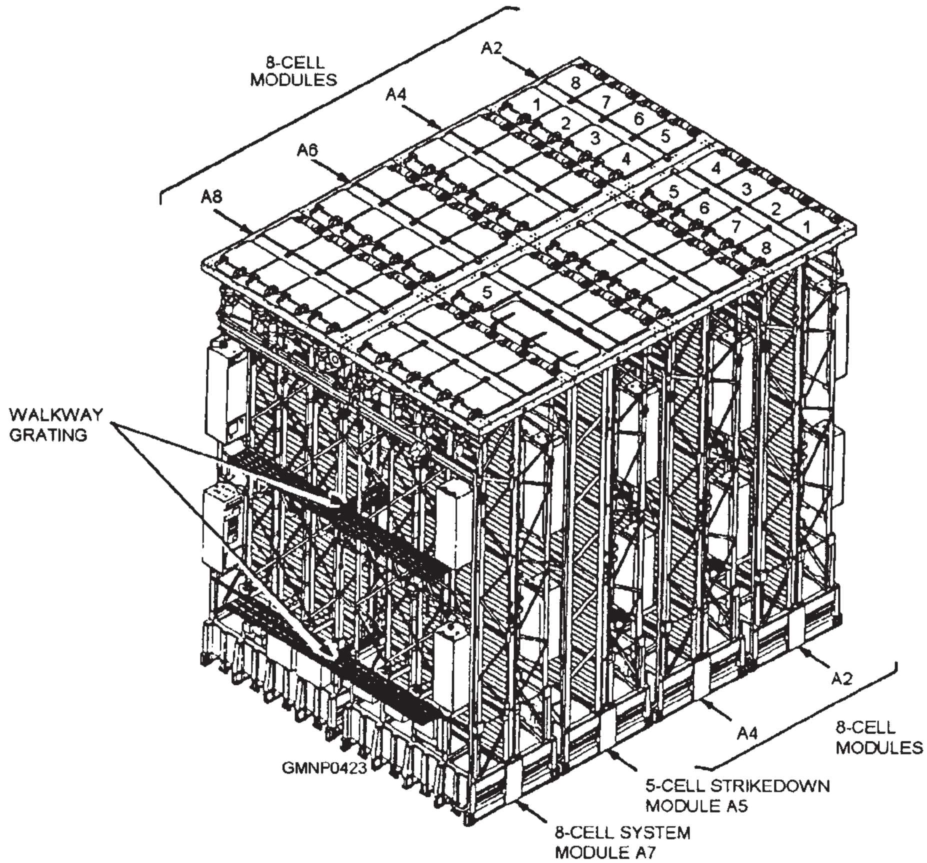


Figure 7-44.—Vertical launcher Mk 158 Mod 0.

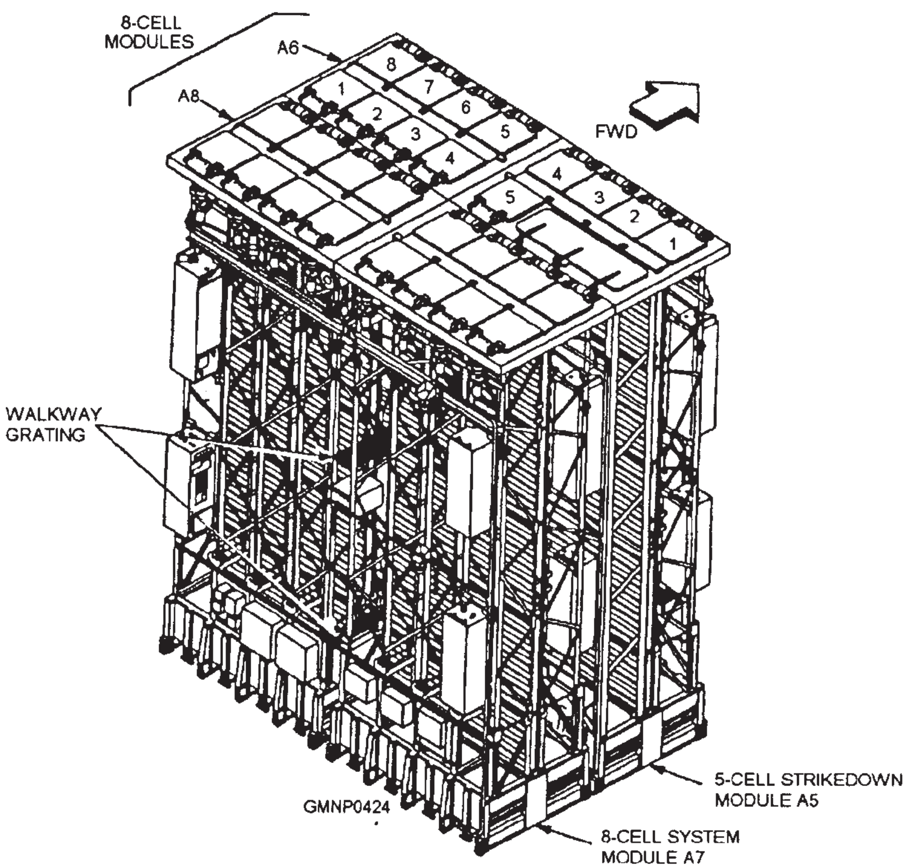


Figure 7-45.—Vertical launcher Mk 159 Mod 0.

housed in watertight compartments that extend vertically from the second platform to the 01 level in all three ship classes.

The module is the primary structure component of the VLS launcher (fig. 7-46). It consists of the deck structure, the intermediate structure, and the base structure.

On the 8-cell module, the deck structure consists of eight cell hatches and an uptake hatch. The deck structure provides ballistic protection and supports the upper ends of the canisters. The deck structure is part of the gas management system that prevents rocket motor exhaust gases from escaping into the open launcher area. All hatches (with the exception of the strikedown hatch) contain heating elements to prevent icing. The cell hatches and uptake hatches are automatically opened by individual drive motors before missile launch. After a 10-second delay, to permit venting of the remaining missile exhaust gases in the launcher cells, the cell hatches automatically close.

The intermediate structure forms the midsection of the module and is also a part of the gas management system. It consists of five uptake sections bolted together and the outboard structures. The uptake sections form a fluelike structure for venting missile exhaust gases. The outboard structures are bolted to the sides of the uptake sections that serve as canister guide rails for installation and removal of canisters.

The base structure serves as a base structure for the module and as a plenum for the gas management system. The intermediate structure mounts directly to the base structure for support of the module and canisters. The interior surface of the plenum and uptake are protected with ablative material to prevent the heat blast from overheating the VLS structure or ship structure.

The launcher sequencer, mounted to the module structure at cell 1, is the interface unit between the controlling LCU, other module equipment, and the missiles. The launcher sequencer monitors the status of the module and the cells within the module.

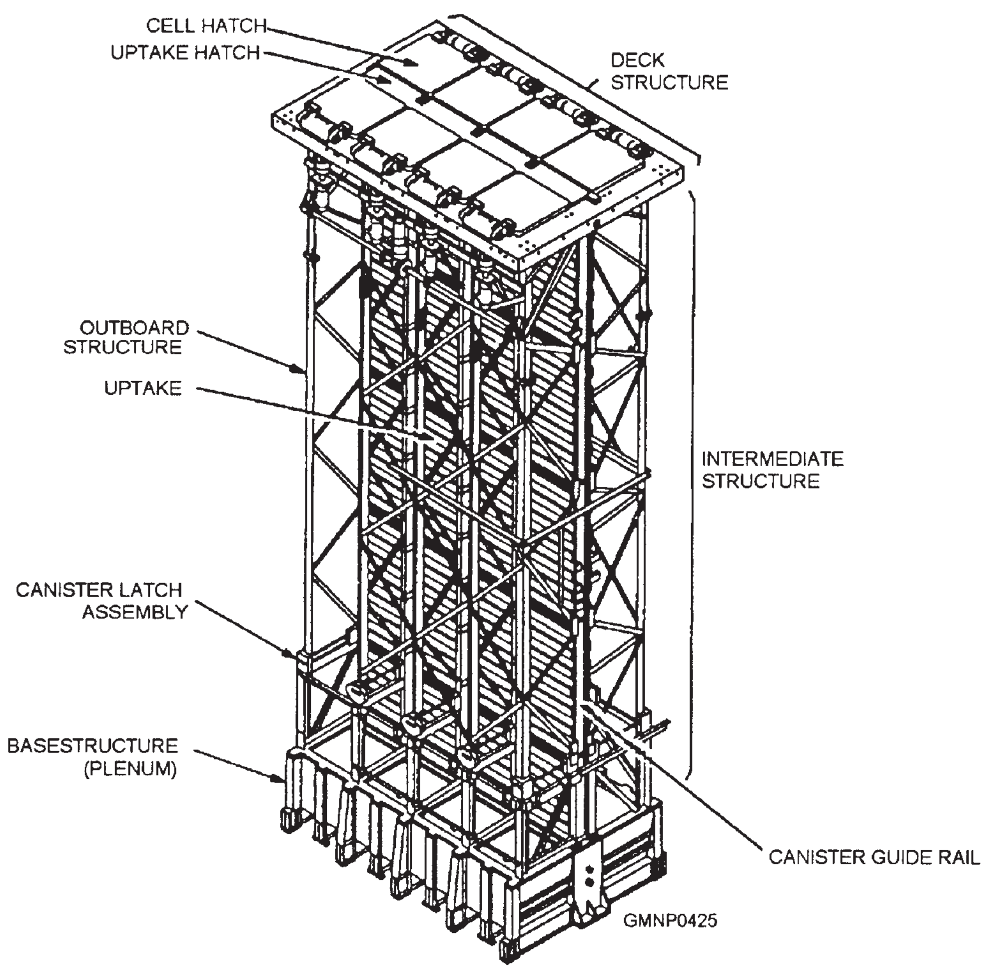


Figure 7-46.—Module structure.

5-CELL STRIKEDOWN MODULE

The 5-Cell Strikedown Module Mk 3 Mod 0 (fig. 7-47) consists of the deck structure, the intermediate structure, the base structure, and the strikedown equipment. The major subassemblies are common to the 8-cell module.

The deck structure consists of 5-cell hatches, 1 uptake hatch, and 1 elevator hatch. The strikedown module related equipment is the same as that for the 8-cell modules, except the elevator hatch replaces cell hatches 6 through 8.

The intermediate structure is the same as that of the 8-cell module, except that the elevator extension structure is part of the outboard structure. The intermediate structure holds four cells on one side of the module—the fifth cell, the elevator, and the crane assembly are on the other side of the module.

The base structure is the same as that for the 8-cell module, except that the elevator and crane in the 5-cell strikedown module replace the area containing cells 6 through 8 on an 8-cell module. There are no cell openings in the plenum at cells 6 through 8.

The strikedown equipment consists of a crane, an elevator, an elevator control panel, an elevator power distribution panel, and a junction box (see fig. 7-47). The crane is a hydraulic extendable boom that is stored below deck. The elevator raises and lowers the crane on

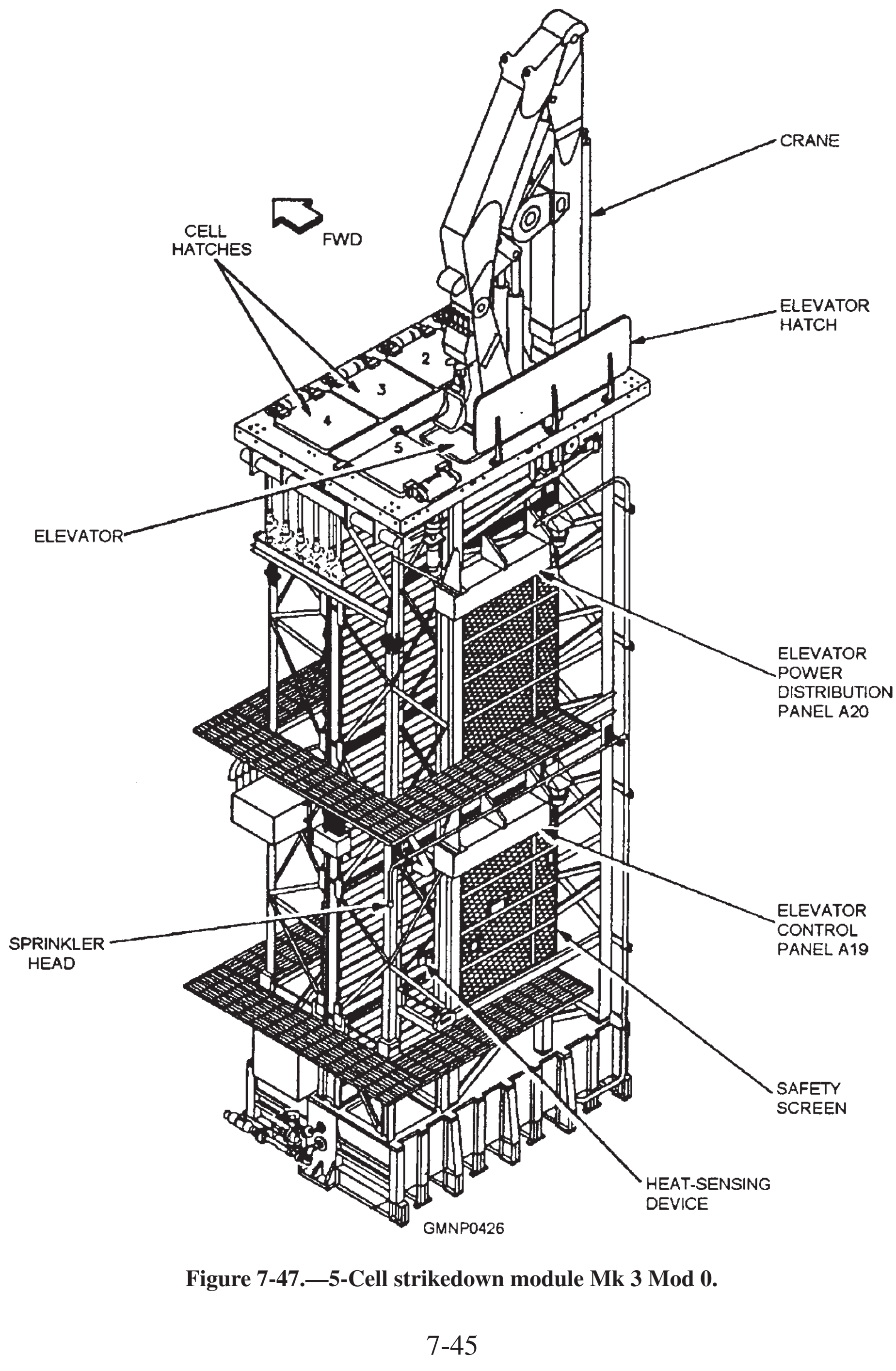


Figure 7-47.—5-Cell strikedown module Mk 3 Mod 0.

its platform by means of a three-stage telescoping hydraulic cylinder, controlled by the elevator control panel. The elevator power distribution panel and junction box provides 440 VAC, 60-Hz, three-phase power to the hydraulic power supply.

LAUNCHER SUPPORT EQUIPMENT

The vertical launcher support equipment consists of a sill adapter assembly, a canister adapter, and a plenum cell cover that are coated with a heat-absorbing ablative material that protects the equipment from heat damage.

The sill adapter assembly is an open, funnel-like, steel weldment assembly that provides the lower mating surface for the missile canisters. The sill assembly also directs missile exhaust away from the sides of the missile cell and into the plenum.

The canister adapter is a combination nozzle and spacer installed under the bottom of the canister to prevent rocket motor exhaust gases from circulating back into the canister. When used in an empty cell, the canister adapter holds the plenum cover at latching height.

The plenum cell cover is used with the canister adapter to seal cell openings when a canister is not in place. The cover also prevents gas from missile firings in that module from entering the empty cell.

GAS MANAGEMENT SYSTEM

The gas management system includes all the systems, assemblies, adapters, and covers that were discussed in the vertical launcher and launcher support equipment sections. The purpose of the gas management system is to direct exhaust gases from a missile firing to the external atmosphere.

Another part of gas management is the blowout system. It removes toxic fumes from the launcher by opening vent lines and activating the motor controller of the vent fan. After a missile firing, the blowout system must be operated for a minimum of 20 minutes before personnel enter the launcher and for 1 minute each hour thereafter that personnel remain in the launcher.

POWER DISTRIBUTION

The VLS power distribution consists of an ac power distribution system THAT applies 60-Hz, three-phase, 115 VAC and 440 VAC to the motor control panel (MCP), power distribution panels, system transformer platform, and module transformer platform. Dc power is produced within the MCP for equipment use outside of the MCP, such as prelaunch operations, hatch motors, and the Tomahawk missile prelaunch phase.

FAULT PROCESSING

Fault processing is the detection and reporting of faults within the VLS. This process can be accomplished by system level fault detection and reporting operations or local level built-in test equipment (BITE) tests.

System level BITE tests are conducted only when the VLS is in standby mode and LAUNCH ENABLE is not applied to the launcher. The LCU initiates a system level BITE test within approximately 30 seconds from the time the VLS is placed in the standby mode and every 2 hours thereafter. Other system BITE tests include the LCU, single module, system module, and deluge BITE tests.

SUMMARY

In this chapter we described the major GMLSs currently in the fleet, focusing on the major components, function, and operation. In subsequent chapters we will discuss their secondary and auxiliary equipment, guided missiles, ordnance handing equipment, and other maintenance requirements associated with the different types of GMLSs.